A PRACTITIONER'S APPROACH FOR PROBLEM-SOLVING USING AI

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PREFACE

Artificial intelligence (AI) and machine learning (ML) are revolutionizing the way we approach healthcare and various industries. AI and ML are being used to improve patient outcomes, reduce costs, and increase efficiency in the healthcare industry. AI is also being used in medical devices to predict and identify diseases, classify data for disease outbreaks, and optimize medical therapy.

In this book, we explore the role of neural networks in AI and ML in the medical and health sectors. Neural networks are being used in oncology to train algorithms that can identify cancerous tissues at the microscopic level with the same accuracy as trained physicians. Various rare diseases may manifest in physical characteristics that can be identified in their premature stages by facial analysis of patient photos.

The book also explores the role of AI and ML in various industries such as finance, retail, manufacturing, and more. AI is being used to improve customer experience by providing personalized recommendations based on customer data. In manufacturing, AI is being used to optimize supply chain management by predicting demand and reducing waste.

This book is a comprehensive guide for anyone interested in learning about the role of AI and ML in medical, health sectors, and various industries.

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CHAPTER 1

Redefining Human-AI Interactions: Unveiling ChatGPT's Profound Emotional Understanding

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Abstract: The AI-powered conversational agent known as ChatGPT has received significant attention due to its exceptional performance in natural language processing tasks and its exponential growth in user base. While ChatGPT has demonstrated its ability to generate knowledge across various domains, its proficiency in identifying and expressing emotions remains uncertain. Recognizing and understanding emotional states, both in oneself and others, is widely acknowledged as a crucial aspect of mental health, referred to as emotional awareness (EA). The present study employed the Levels of Emotional Awareness Scale (LEAS) as a standardized and task-oriented metric to assess the efficacy of ChatGPT in addressing twenty distinct scenarios. The present investigation sought to conduct a comparative analysis of ChatGPT's proficiency in emotional awareness (EA) *vis-à-vis* the general populace, ascertained through prior scholarly inquiry. A follow-up evaluation was conducted one month later to assess potential improvements in ChatGPT's emotional intelligence algorithm over time. Additionally, licensed psychologists independently evaluated the appropriateness of ChatGPT's EA responses in the given context. The preliminary evaluation indicates that ChatGPT exhibits a considerably greater level of proficiency in all aspects of the LEAS in comparison to the general populace, as evidenced by a Z score of 2.79. The post-evaluation analysis revealed a significant enhancement in the operational efficiency of ChatGPT, exhibiting a close proximity to the highest achievable LEAS score, Z score = 4.15. Furthermore, ChatGPT exhibited a statistically significant level of precision, achieving a score of 9.7 out of 10. These findings suggest that ChatGPT exhibits a high level of proficiency in generating appropriate responses for EA, and its effectiveness may significantly improve over time. The results have important implications in both theoretical and practical contexts. Integrating ChatGPT into cognitive training programs could hold potential for addressing executive attention deficits in clinical populations. Moreover, ChatGPT's EA-like capabilities can aid in the assessment and diagnosis of psychiatric disorders, as well as advancing our understanding of emotional language. Additional investigation is required to comprehensively scrutinize the potential advantages and disadvantages of ChatGPT and optimize its application for advancing psychological well-being.

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Keywords: ChatGPT, Conversational agent, Emotional awareness (EA), LEAS, Natural language processing.

1. INTRODUCTION

The AI-based conversational agent, ChatGPT1, has garnered considerable recognition for its adeptness in diverse natural language processing assignments. The consumer application industry has witnessed a remarkable achievement in the form of ChatGPT1, which has garnered an astounding 100 million monthly active users within a short span of two months since its inception. This unprecedented growth rate has set a new benchmark in the industry [1]. The language model in question has undergone rigorous training on copious amounts of textual data, resulting in its ability to produce responses that bear a striking resemblance to human language when presented with text-based inputs [2]. Whilst natural language processing models have made significant strides, it is crucial to acknowledge that extensive language models remain vulnerable to producing responses that lack adequate substantiation from the input source, resulting in the propagation of erroneous or untrustworthy data [3]. The preliminary investigations have indicated the proficiency of ChatGPT1 in producing information in various fields, including medical licensing exams [4] and academic writing [5]. However, the identification and expression of emotions by ChatGPT1 necessitate further investigation.

The field of machine learning, which falls under the umbrella of artificial intelligence, has experienced a swift and pervasive integration into our daily routines, resulting in a profound influence on multiple facets of our being [6]. The recent breakthroughs in artificial intelligence, exemplified by the GPT-3 language model, have sparked a transformative paradigm shift in the field [7]. The integration of machine learning algorithms into various technologies has facilitated the implementation of personalized recommendations, voice assistants, fraud detection, and autonomous vehicles, among a plethora of other applications. The advent of GPT-3 has enabled machines to generate text that closely resembles human language, thereby enhancing various domains such as customer service, content generation, and virtual companionship [8]. As the advancements in this field persist, it holds the potential to transform various industries such as education, healthcare, and beyond [9]. The advent of machine learning is poised to revolutionize the way we live, work, and interact with the world, ushering in an era of unparalleled efficiency, innovation, and opportunities [10 - 16].

2. THE POTENTIAL IMPACT OF ARTIFICIAL INTELLIGENCE (AI) ON MENTAL HEALTH

In the contemporary era, a substantial amount of scientific inquiry has been devoted to investigating the prospective influence of artificial intelligence (AI) on the domain of mental health. The existing literature indicates a multitude of potential use cases for artificial intelligence, such as facilitating diagnostic procedures [17] and streamlining administrative tasks to enable healthcare providers to devote more time to patient care [18]. Gaming powered by artificial intelligence (AI) holds promise in enhancing social motivation and attention performance, ultimately leading to positive impacts on mental health [19]. The recent review by [20] highlights the potential utility of AI chatbots in the field of mental health. The Woebot conversational agent is an AI-based tool that has been developed with the specific aim of providing cognitive behavioral therapy (CBT) for the purpose of managing anxiety and depression. As per the findings of a study [21], Woebot utilizes acquired cognitive abilities to identify and rectify cognitive distortions, thereby keeping a check on symptoms and episodes linked to mental health ailments. The Replika therapy methodology is a novel approach that leverages avatars to enable therapeutic dialogues between users and their virtual counterparts. The proposed approach entails the reconstruction of a comprehensive personality profile through the analysis of the user's digital remnants or textual interactions. According to a study [22], Replika facilitates open and impartial conversations, which promote introspection and augment individuals' comprehension of their personality. In the present investigation [23], a clinical trial was carried out to assess the efficacy of their Therapy Empowerment Opportunity (TEO) application in enhancing the psychological state and general welfare of geriatric populations. The TEO application has been developed with the aim of enabling the retrieval and deliberation of incidents that could have potentially led to escalated levels of anxiety in patients. Furthermore, the aforementioned software provides remedial activities and suggestions to bolster the convalescence procedure. The present utilization of artificial intelligence (AI) in the field of mental health is subject to certain constraints with respect to emotional awareness (EA) capabilities [24]. The aim of this study is to assess the precise extent of ChatGPT's artificial intelligence capacities with regard to emotional analysis [25 - 30].

The decision to designate ChatGPT as a representative artificial intelligence technology was predicated upon two fundamental criteria. The ubiquitous deployment of ChatGPT in the public sphere renders it a captivating topic for scientific inquiry. Moreover, the tool's design lacks specificity toward mental health applications or the cultivation of soft skills, such as emotional intelligence, as it is primarily intended for general-purpose utilization.

CHAPTER 2

Neuromorphic Computing: Forging a Link between Artificial Intelligence and Neurological Models

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Abstract: By emulating the design and operation of the human brain, neuromorphic computing promises to close the gap between artificial intelligence and brain-inspired technologies. Researchers create specialized hardware and software to mimic the brain's processing speed, capacity for learning, and energy economy. This chapter examines the drivers, difficulties, and prospective uses of neuromorphic computing, with a focus on robotics, sensory processing, and pattern recognition. The entire potential of brain-inspired systems will be unlocked by ongoing research, revolutionizing the field of AI and paving the way for the creation of cutting-edge, intelligent machines that follow the principles of the brain.

Keywords: Connected and autonomous vehicles (CAVs), Cyber security, Federated learning, Vehicular network.

1. INTRODUCTION

The mysterious capacity of the human brain has long attracted academics and researchers in the field of artificial intelligence (AI). The brain's amazing capacity for quick and efficient decision-making, learning from experience, and information processing has fuelled research into how it works and efforts to reproduce these talents. As a result, the study of neuromorphic computing—which aims to close the gap between AI and brain-inspired systems—has arisen.

Fundamentally, neuromorphic computing is the fusion of engineering, computer science, and neurology, encompassing the creation of intelligent systems that can observe, learn, reason, and make choices similar to their biological counterparts

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by designing and developing computer architectures and algorithms that imitate the structure and operation of the brain [1].

The desire to get around the constraints of conventional computer paradigms is what drives neuromorphic computing. Even if traditional computers have made great advancements in terms of processing speed and data storage, they are still nothing compared to the unmatched talents of the human brain. Real-time sensing, cognitive processing, and energy efficiency are challenges that traditional systems struggle with but where the brain thrives naturally [2].

Unlock the enormous potential trapped inside the neuronal architecture of the brain is one of the main reasons for exploring the field of neuromorphic computing. The brain's billions of linked neurons build intricate networks that speed up the processing and transport of information, we can see a representation in Fig. (**1**). These networks' innate flexibility allows for learning and memory creation, which is still a significant problem for conventional AI systems [3].

Fig. (1). Showcasing the world of neuromorphic computing.

To recreate brain networks, neuromorphic computing uses specialized hardware and software to discover their secrets. Researchers want to create computer systems that have brain-like cognitive capacities by modeling the behavior of neurons and synapses. These systems have the potential to handle enormous volumes of data concurrently, identify patterns, and make wise judgments in real time [4].

Additionally, energy efficiency, one of the most important problems in modern computing, may be solved through neuromorphic computing. Concerns about sustainability and environmental effects arise as traditional computing systems' energy consumption soar in response to their increasing power. In sharp contrast, the human brain is a wonder of energy efficiency, using only a few watts of electricity despite its incredible processing capacity. Neuromorphic computing aims to produce hardware and algorithms that can function with exceptional efficiency, reducing the environmental impact associated with computing by taking inspiration from the brain's energy-efficient architecture [5]. Neuromorphic computing has a wide range of uses across several industries. Robotics will greatly benefit from the incorporation of brain-inspired systems since it will enable the creation of intelligent robots that can sense and interact with their surroundings in real time. Robots can navigate challenging situations, carry out difficult jobs, and adjust to changing conditions if they can interpret sensory data quickly and make intelligent judgments.

Another area where neuromorphic computing has enormous potential is sensory processing. Applications like picture and speech recognition can achieve previously unheard-of levels of accuracy and speed by making use of the brain's capacity to interpret sensory data in real time. Fields like healthcare, where prompt and precise diagnosis is essential, or autonomous cars, where split-second decision-making can be the difference between safety and tragedy, can benefit greatly from real-time sensor data processing [6].

Another field that neuromorphic computing has the potential to revolutionize is pattern recognition. Researchers have created sophisticated algorithms that can mimic the brain's capacity to recognize intricate patterns in data, including textual and visual patterns. These developments can potentially revolutionize industries that depend on the capacity to spot patterns and abnormalities, such as data analysis, anomaly detection, and fraud protection. The possibilities for the future of neuromorphic computing are fascinating as we learn more about it. As the secrets of the brain are revealed through ongoing study and advancements, neuromorphic designs can be improved [7]. The possibility of very sophisticated, brain-like computational systems is becoming more and more feasible as we continue to close the gap between AI and brain-inspired systems. These

CHAPTER 3

Fingerprint Recognition System Study

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Abstract: Due to its broad use in fields including law enforcement, access control, and personal identity, fingerprint recognition systems have attracted a lot of interest in recent years. This paper offers a thorough examination of fingerprint recognition systems, concentrating on their underlying ideas, methods, and performance assessment. The study starts by giving a general review of the biometric identification sector while highlighting how distinct and stable fingerprints are as a trustworthy form of personal identification. Highlighting significant turning points and developments, it examines the historical evolution of fingerprint identification systems from manual fingerprint analysis to automated digital systems. This research seeks to increase the knowledge of biometric identification technologies by offering a thorough review of fingerprint recognition systems. Researchers, professionals, and politicians interested in the creation and deployment of safe and effective fingerprint recognition systems for a variety of applications can benefit from the discoveries and insights offered.

Keywords: Biometric technology, Fingerprint system.

1. INTRODUCTION

One of the most trustworthy and popular biometric identification methods is fingerprint recognition technology. In a variety of settings, including law enforcement, access control, and personal device security, the distinctive patterns and traits of fingerprints provide an unprecedented level of individuality. In terms of accuracy, speed, and usefulness, fingerprint recognition technologies have made tremendous strides over time. The area of fingerprint analysis has advanced

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significantly from the earliest manual techniques to the introduction of automated digital technologies [1]. These systems now play a crucial role in many aspects of our everyday lives, from unlocking devices to protecting critical locations. This study's goal is to offer a thorough examination of fingerprint recognition systems, looking at their underlying theories, methods, and performance assessment [2]. We may learn more about the essential elements and procedures that make up these systems and acquire an awareness of their advantages, disadvantages, and potential in the future. The first point made in the study is how distinctive and reliable fingerprints are as a biometric identification tool. It explores the progress of fingerprint identification systems across time, from the first manual ink and paper techniques to the current digital systems powered by cutting-edge algorithms and sensor technology [3]. There is a thorough discussion of the fundamental elements of fingerprint recognition systems. This comprises the picture capture phase, during which several sensing modalities including optical, capacitive, and ultrasound-based scanners are evaluated. To comprehend the procedures required to enhance the quality and dependability of fingerprint photographs, the preprocessing stage, which involves image improvement and noise reduction techniques, is also studied. An extensive investigation is conducted into feature extraction, a critical step in fingerprint identification [4]. The classic minutiae-based method is described in depth and concentrates on extracting special features like ridge ends and bifurcations. Additionally, more recent methods are investigated for their potential to improve recognition resilience and accuracy, including the use of deep learning techniques, ridge-based analysis, and texture analysis. Comparison and analysis are done on matching algorithms, another crucial component of fingerprint recognition systems [5]. To comprehend the benefits and drawbacks of minutiae-based matching *vs.* conventional correlation-based matching techniques, minutiae descriptors, and minutiae matching are explained. To evaluate the effectiveness and security concerns of fingerprint recognition systems, performance assessment parameters such as the False Acceptance Rate (FAR) and False Rejection Rate (FRR) are looked at. The paper also discusses several issues that these systems must deal with, such as picture quality, noise, distortion, and possible spoofing attempts. Finally, the paper provides a summary of current developments and developments in the field of fingerprint identification. The possible future possibilities of this discipline are highlighted by discussions of multimodal biometrics, fusion approaches, and the integration of fingerprint recognition with cutting-edge technologies like the Internet of Things (IoT) and mobile devices [6].

This research seeks to increase the knowledge of biometric identification technologies by offering a thorough review of fingerprint recognition systems. For academics, practitioners, and policymakers engaged in the creation and use of safe

and effective fingerprint recognition systems for a variety of applications, the ideas and findings offered here might be a useful resource [7, 8].

2. FINGERPRINT

The ridges and valleys on the fingertips of humans and certain monkeys create distinctive patterns that are called fingerprints. These patterns serve as a good biometric identification since they are created during fetal development and are constant throughout an individual's lifespan. Dactyloscopy, the study of fingerprints, has been a mainstay of forensic science and individual identification for more than a century [9, 10].

Loops, whorls, and arches are the three primary forms of fingerprints. Loops make up the majority of fingerprints—60–65% of all fingerprints—and are the most prevalent kind. These fingers feature one or more ridges that enter from one side, curve around, and emerge from that same side. Whorls, which make up between 30 and 35 percent of fingerprints, contain spiral or circular patterns with at least one ridge that forms full circuit (Fig. **1**).

Fig. (1). A sensor's picture of a fingerprint.

Systems for fingerprint identification provide several benefits, such as high accuracy, quick processing, and simplicity. Law enforcement, border control, access control, mobile devices, and financial transactions are just a few of the industries where they have applications. Fingerprints are a trustworthy form of personal identification due to their consistency and individuality, and advances in fingerprint recognition technology continue to expand their potential [11 - 14].

In conclusion, fingerprints are distinctive and reliable biometric indicators that have long been employed in forensic and personal identification processes. To

CHAPTER 4

Glaucoma Detection with Retinal Fundus Images

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Abstract: This paper discusses numerous methods for glaucoma detection. Because of its impact on the optic nerve and the loss of ganglion cells, which eventually results in vision loss, glaucoma has emerged as the leading cause of blindness worldwide. In this article, we provide a few methods for recognizing glaucoma in its earliest stages, which can prevent irreversible damage to a person's vision. We explore ROI (region of interest), optic cup and disc ratio, LSACM, and LSACM-SP techniques in this research, all of which help us achieve significant segmentation results. The development of diagnostic methods for several eye illnesses began with the discovery of the "optical disc (OD)". To produce circular OD milestones, this methodology rounds extrinsic morphology and detecting methodologies. The OD's pixels must be provided as raw data. To achieve this, a methodology based on the chosen voting method is devised.

Keywords: Connected and autonomous vehicles (CAVs), Cyber security, Federated learning, Vehicular networks.

1. INTRODUCTION

In the modern world, glaucoma is one of the most common causes of total visual loss. It has been estimated that between 70 and 80 million individuals will suffer from this ailment by the end of 2020, with millions of people being impacted each year. The irreparable damage caused by glaucoma to the eye's optic nerves can

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permanently harm the retina and cause total blindness or visual loss [1]. Early detection of glaucoma symptoms allows for treatment or slowing of optic nerve deterioration. Ophthalmologists can determine how much damage has been done to the optic nerves and retina by video testing the fundus images of the eye, but this procedure is optional and based on individual preferences. Additionally, these tests are time-consuming and expensive. Therefore, automatic glaucoma testing, where two different sections of the eye are monitored is thought to be effective. Within the eye's optic disc are these two distinct sections [2]. The “optic cup” is the bright core area, and the “neuroretinal rim” is the “peripheral” section situated between the disc's edges. Numerous different steps could be made to investigate and determine distinguishing characteristics of the “optic disc” by looking at its features. But there are also effective methods like the cup-to-disc ratio (CDR), notching, and ISNT rule that are less tiring and demanding [3]. Although the methodologies are inconsistent with one another, it is nevertheless important to understand the cup-to-disc ratio, optic cup, and optic border [4].

These are the main categories into which glaucoma is divided:

First, Open Angle Glaucoma: The most prevalent type of glaucoma is this one. This condition is also known as “Wide Angle Glaucoma” and is among one of the basic types of glaucoma. It happens when the drainage canal is under pressure from fluid retention brought on by a blockage, as shown in Fig. (**1**).

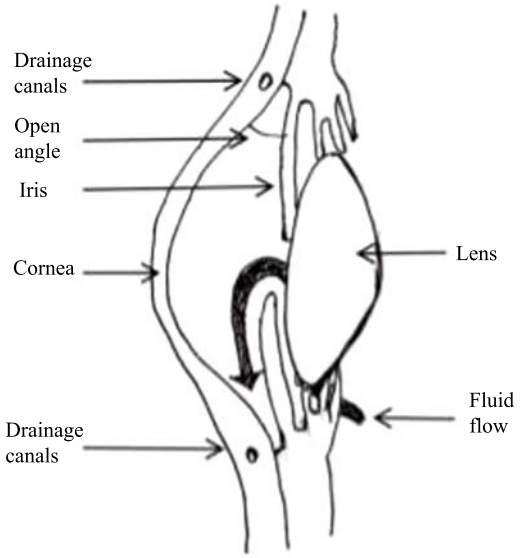

Fig. (1). Open-angle glaucoma.

Second, Angle Closure Glaucoma: Angle-closure glaucoma is brought on by an abrupt and complete blockage of the watery drainage canal. As illustrated in Fig. (**2**), it is also known as acute glaucoma [5].

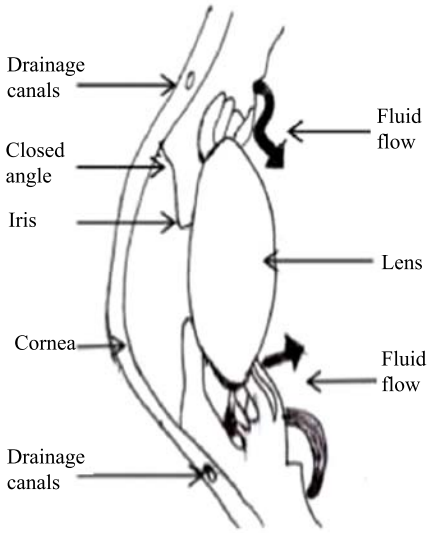

Fig. (2). Acute glaucoma.

2. DETECTION OF GLAUCOMA

An ophthalmologist or an optometrist will normally perform a thorough eye examination to detect glaucoma. The following are some popular techniques and tests for glaucoma detection:

Tonometry: This test measures intraocular pressure (IOP) to determine if it is normal or higher because a high IOP is a major glaucoma risk factor. Tonometry can be carried out with a variety of instruments, including handheld tonometers, non-contact tonometers, and the Goldmann applanation tonometer [6, 7].

Ophthalmoscopy: Also referred to as fundoscopy, this procedure uses an ophthalmoscope to look at the optic nerve at the back of the eye. The optic nerve head is examined by the ophthalmologist or optometrist to check for any injury or glaucoma-related abnormalities, such as cupping or thinned nerve fibres [8].

Visual Field Testing: This examination evaluates peripheral (side) vision and aids in the identification of any anomalies or loss of visual field that may suggest glaucoma. The patient responds to light stimuli delivered in various regions of their visual field during automated perimetry, one of the approaches that can be used to conduct this task. The optic nerve, retina, and other tissues in the back of

CHAPTER 5

Detection of Lung Cancer using Image Processing Methods

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Abstract: The largest cause of cancer-related fatalities globally is lung cancer. Lung cancer treatment results and survival rates can be considerably enhanced by early identification and diagnosis. Image processing techniques have attracted attention as useful tools for the early identification and diagnosis of lung cancer because of improvements in medical imaging technology. This review study offers a thorough examination of the various image-processing methods used in lung cancer diagnosis. The importance of early detection and the difficulties in conventional diagnosis techniques are covered in the first section of the paper. The potential of image processing methods to solve these issues and boost diagnostic precision is then highlighted. The review discusses several feature extraction, segmentation, and classification techniques used in lung cancer diagnosis. The precise detection and delineation of lung tumors from computed tomography (CT) scan or chest X-ray images is investigated using image segmentation algorithms. To get pertinent data and traits from the segmented tumor areas, feature extraction techniques are next examined. In the end, classification methods are looked at for separating benign and malignant tumors based on the data retrieved. The research also examines the combination of image processing methods with machine learning and deep learning algorithms for improved lung cancer diagnosis. It draws attention to the benefits and drawbacks of these algorithms in terms of increasing diagnostic precision and lowering false-positive or false-negative outcomes. The study concluded with a discussion of the potential applications of image-processing techniques in the diagnosis of lung cancer. It emphasizes how computer-aided diagnostic methods and artificial intelligence have the

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potential to revolutionize the detection and treatment of lung cancer. In conclusion, this paper offers a thorough overview of the image processing techniques used in lung cancer diagnosis. It clarifies how these methods could aid in the early detection of lung cancer, improve the design of the appropriate course of therapy, and eventually improve patient outcomes.

Keywords: Image processing, Lung cancer, X-rays image.

1. INTRODUCTION

With a high death rate, lung cancer continues to be one of the most common and lethal types of cancer in the world. Improving patient outcomes and putting into place prompt and efficient treatment plans depend heavily on early detection and precise diagnosis. Chest X-rays and computed tomography (CT) scans are particularly important for the identification and characterization of lung tumors in medical imaging. However, the manual analysis of these photos involves subjectivity, takes time, and is vulnerable to human mistakes. A possible solution to these problems and to improve lung cancer diagnosis is to use image processing techniques. Image processing facilitates the extraction of useful information from medical pictures, resulting in increased accuracy, efficacy, and objectivity in diagnosis [1]. This is done by utilizing computer algorithms and automated analytic techniques. A review of the various image processing techniques for lung cancer diagnosis is the goal of this research. The importance of early detection, the shortcomings of conventional diagnostic approaches, and the potential advantages of using image processing techniques will all be covered. In addition, the study will go through the crucial procedures of image segmentation, feature extraction, and classification in the pipeline of image processing for lung cancer diagnosis [2, 3]. By locating and defining the tumor zone within medical pictures, image segmentation enables accurate localization and assessment of lung lesions. Accurate tumour segmentation has been achieved using a variety of segmentation approaches, including thresholding, region-based methods, and active contours. The goal of feature extraction is to isolate pertinent traits from the segmented tumour area. Shape descriptors, textural characteristics, or statistical measures are a few examples of these traits that may be used to differentiate between benign and malignant tumors. The collected characteristics are then subjected to classification algorithms to distinguish between various forms of lung lesions. In this context, machine learning and deep learning approaches have drawn a lot of attention since they enable the creation of prediction models that correctly categorise lung tumours using attributes acquired from the images [Sharma, V., Patel, R. B., Bhadauria, H. S., & Prasad, D. (2016)]. Researchers and doctors may be able to increase the precision and effectiveness of lung cancer diagnosis through the use of image processing techniques, resulting in earlier identification

and more focused treatment strategies. Furthermore, combining image processing methods with artificial intelligence and computer-aided diagnosis systems has enormous potential for improving the ability to identify lung cancer and helping medical practitioners make wise judgments.

2. COMPONENTS AND METHOD

Dataset obtaining: Obtain a collection of pictures from chest X-rays or CT scans of people who have been diagnosed with lung cancer. For appropriate classification, make sure the dataset has a significant number of instances with both benign and malignant lung tumors.

Preprocessing: Preprocessing is done to improve image quality and get rid of noise and artifacts. To standardize the photos, use methods like image resizing, normalization, and filtering [4 - 7].

Segmenting images: Use segmentation methods to isolate the tumor location and separate the lung region from the surrounding area. Thresholding, region-growing, dynamic contours (such as level sets or snakes), or methods based on deep learning are examples of common segmentation techniques.

Extracting Features: To gather discriminating information, extract pertinent aspects from the tumor areas that have been segmented.

Think about several methods of feature extraction, including shape descriptors (like area, perimeter, and compactness), texture analysis (like Hara lick features and Laws texture energy measures), and statistical measurements (like mean and standard deviation).

Feature Choice: To minimize dimensionality and get rid of pointless or superfluous features, use feature selection. To find the most informative characteristics, use statistical techniques (such as t-tests or ANOVA) or feature ranking algorithms (such as mutual information or chi-square).

Classification: Using the collected characteristics, employ classification algorithms to differentiate between benign and malignant lung tumors. Think about deep learning models (like convolutional neural networks) or machine learning techniques like support vector machines (SVM), random forests, logistic regression, *etc.* For training and evaluating models, divide the dataset into training and testing subsets.

Model Education and Assessment: Utilize the training dataset to train the chosen classification model. Utilize relevant assessment measures to assess the model's performance, including accuracy, sensitivity, specificity, and area under the

CHAPTER 6

Web User Access Path Prediction using Recognition with Recurrent Neural Network

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Abstract: This research introduces a novel technique for predicting web user access paths based on Recognition with Recurrent Neural Network (RNN). The study focuses on utilizing user access paths as the primary research goal and explores the application of RNN in addressing the path forecasting problem. A network model is developed and examined for predicting access paths by enhancing the feature layer. This approach effectively leverages contextual information from user conversation sequences, learns and memorizes user access patterns, and obtains optimal model parameters through training data analysis. Consequently, it enables accurate prediction of the user's next access path. Theoretical analysis and experimental results demonstrate the higher efficiency and improved accuracy of path forecasting achieved by this technique, making it well-suited for solving web user access path prediction problems.

Keywords: Path forecasting, Recognition with recurrent neural network, Contextual information, Long short-term memory (LSTM), User access patterns, Web user path prediction.

1. INTRODUCTION

Predicting web user access paths plays a crucial role in enhancing user experience, personalization, and optimizing web services. Recognizing the significance of this problem, this research proposes a novel technique that utilizes

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Recognition with Recurrent Neural Network (RNN) for path prediction. By incorporating RNN into the path forecasting problem, the study aims to develop a network model capable of accurately predicting the next access path of web users.

In this research, the conventional RNN model is extended by introducing additional layers to capture more discriminative features. Furthermore, Long & Short Term Memory (L&STM) units are integrated into the hidden layer to effectively remember both short and long-term dependencies within the user conversation sequences. This approach enables the utilization of contextual information and the learning and memory of user access patterns.

To obtain optimal model parameters, the proposed technique leverages training data to train the network model [1]. Through a thorough analysis of the training data, the model learns the access rules and captures the underlying patterns in user behavior. Subsequently, it utilizes this learned knowledge to predict the user's next access path accurately.

The effectiveness and accuracy of the proposed technique are evaluated through theoretical analysis and extensive experimentation [2]. The experimental results demonstrate superior path forecasting efficiency and improved prediction accuracy compared to existing methods. Thus, this research contributes to addressing the web user access path prediction problem and provides a suitable solution for improving the overall user experience and web service optimization. Predicting web user access paths is a vital task that can greatly impact user experience, personalization, and web service optimization. Understanding the importance of this problem, the focus of this research is to introduce a novel technique for path prediction that utilizes Recognition with Recurrent Neural Network (RNN). By incorporating RNN into the path forecasting problem, the study aims to develop a network model that can accurately predict the next access path of web users [3 - 5].

In this research, the conventional RNN model is extended to enhance its capability to capture more discriminative features. Additional layers are introduced to the network architecture, allowing for the extraction of richer and more representative features from the input data. Moreover, Long & Short Term Memory (L&STM) units are integrated into the hidden layer of the network. LSTM units are designed to effectively capture and remember both short and long-term dependencies within the user conversation sequences. By incorporating LSTM units, the model can leverage contextual information and learn and memorize user access patterns over time, leading to more accurate predictions.

To train the network model and obtain optimal model parameters, the proposed technique utilizes training data. The training data is carefully analyzed to identify

access rules and capture the underlying patterns in user behavior [6 - 8]. Through this analysis, the model learns the relationships between different access paths and user characteristics, enabling it to make informed predictions about the next access path. By leveraging the knowledge gained from the training data, the model can accurately predict the user's next access path in real-time scenarios.

To evaluate the effectiveness and accuracy of the proposed technique, extensive theoretical analysis and experimentation are conducted. The experimental results demonstrate the superior path forecasting efficiency and improved prediction accuracy achieved by the proposed model compared to existing methods. The model successfully incorporates both short and long-term dependencies, allowing it to capture nuanced patterns and make precise predictions. These findings highlight the potential of the proposed technique in addressing the challenging web user access path prediction problem.

By accurately predicting web user access paths, the proposed technique offers several benefits for enhancing user experience and optimizing web services [9 - 11]. Firstly, it enables personalized recommendations and tailored content delivery, ensuring that users are presented with relevant information based on their predicted access paths. This customization leads to a more engaging and satisfying user experience. Secondly, the accurate prediction of access paths facilitates efficient resource allocation and load balancing on web servers. By anticipating user access patterns, web service providers can optimize their infrastructure to ensure smooth and responsive user interactions. Finally, the proposed technique contributes to the overall improvement of web service optimization. By understanding and predicting user behavior, service providers can make informed decisions about content placement, user interface design, and marketing strategies.

This research introduces a novel technique for predicting web user access paths using Recognition with Recurrent Neural Network (RNN) [12]. The technique extends the conventional RNN model by incorporating additional layers and integrating Long & Short Term Memory (L&STM) units to capture both short and long-term dependencies. Through extensive experimentation, the proposed technique demonstrates superior path forecasting efficiency and improved prediction accuracy compared to existing methods. By accurately predicting web user access paths, this technique contributes to enhancing user experience, personalization, and web service optimization. The findings of this research provide a valuable solution for addressing the web user access path prediction problem and offer insights into improving the overall effectiveness of web services [13 - 17].

CHAPTER 7

News Event Detection Methods Based on Big Data Processing Techniques

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Abstract: This research presents a novel approach for detecting news events using big data processing techniques. The proposed method involves four key steps: crawling news data from various news portal websites, filtering noise and removing duplicates, performing named entity recognition and text summarization, detecting media events through text clustering and feature extraction, and finally displaying the detected news topics through an intuitive interface. By leveraging static and dynamic web page crawler technologies, this method harnesses the power of big data to effectively identify and track news events. Experimental results demonstrate the effectiveness of the proposed approach in accurately detecting and presenting news topics.

Keywords: Big data processing, Feature extraction, Interface, Noise filtering, News event detection, Named entity recognition, Text summarization, Text clustering, Web page crawler.

1. INTRODUCTION

With the rapid growth of digital media and the availability of vast amounts of news data, it has become increasingly challenging to identify and track news events manually. To address this issue, this research proposes a news event detec-

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tion method that leverages big data processing techniques. The method comprises several steps aimed at crawling news data from various sources, filtering noise, removing duplicates, performing named entity recognition, and generating concise summaries of news articles. In the subsequent phase, the method employs participle techniques, feature extraction, and feature dimension reduction to identify relevant features and reduce the dimensionality of the data [1]. By applying text clustering algorithms, media events are detected and tracked over time, forming coherent news topics. Finally, the detected news topics are presented to users through an intuitive interface, facilitating easy access and consumption of news information.

The key contributions of this research lie in the effective integration of static and dynamic web page crawler technologies, which enable comprehensive coverage of news data. Additionally, the application of text preprocessing techniques such as noise filtering, duplicate removal, named entity recognition, and text summarization enhances the quality and relevance of the extracted information [2 - 4]. The use of advanced techniques like feature extraction and dimensionality reduction ensures efficient event detection and tracking.

The remainder of this paper is organized as follows: Section 2 provides a detailed description of the data crawling process. Section 3 outlines the methods used for noise filtering, duplicate removal, named entity recognition, and text summarization. Section 4 elaborates on the techniques employed for media event detection, tracking, and the formation of news topics. Section 5 presents the user interface for displaying the detected news topic information. Finally, Section 6 concludes the paper and discusses future research directions.

2. RELATED WORKS

In recent years, internet news has witnessed tremendous growth and has become an essential part of people's lives. Its speed of dissemination, multimedia capabilities, global reach, and interactive features have gradually made it an important medium for accessing the latest information, surpassing traditional forms of communication such as newspapers and broadcasts [5 - 7].

However, the exponential growth of internet information has presented challenges in effectively handling massive amounts of data using conventional software frameworks. To address this issue, big data processing techniques have emerged and quickly developed in recent years. Among these techniques, Spark, a distributed computing system, supports high-speed computation and utilizes Resilient Distributed Datasets (RDD) as a storage object set [8 - 11]. Additionally, it provides the MLlib library for parallel machine learning algorithm execution,

enabling the analysis and extraction of valuable insights from large-scale user access and big data on enterprise platforms.

Furthermore, with the advent of the big data era, traditional databases have struggled to handle the storage, high concurrency, and data access challenges posed by massive datasets [12]. To overcome these issues, NoSQL (non-relational) databases have been introduced. Among them, Couchbase, an open-source distributed NoSQL database with a document-oriented approach, offers a flexible data model, easy scalability, and high availability. It is particularly well-suited for storing a large volume of news document data.

Currently, individuals typically browse news from various portal websites, limiting their access to domestic news from the present day or the past few days. It becomes challenging to obtain comprehensive media event information regarding a particular topic over an extended period [13, 14]. Users also struggle to access news reports from various perspectives or grasp the historical development of an event. To address these limitations, numerous scholars have studied methods and systems for media event detection.

This research aims to contribute to the field of media event detection by proposing a news event detection method based on big data processing techniques. The method involves crawling news data from multiple news portal websites, filtering noise, removing duplicate content, performing named entity recognition, and generating concise news summaries [15 - 18]. It also utilizes techniques such as text clustering, feature extraction, and feature dimension reduction to detect and track media events, resulting in coherent news topics. Finally, an intuitive interface is developed to present the detected news topics effectively.

In the following sections, we will delve into the details of the data crawling process, noise filtering, duplicate removal, named entity recognition, text summarization, media event detection, and the user interface for displaying the detected news topic information. By combining these steps, we aim to provide an efficient and comprehensive solution to the challenges associated with media event detection in the era of big data.

3. RESEARCH METHODOLOGY

The proposed method for news event detection is based on big data processing techniques and consists of four main steps.

In Step 1, news data is obtained by crawling static and dynamic web pages from various news portal websites [19 - 22]. The static web page crawler technology, implemented with Scrapy, follows regular expression rules to crawl target URLs

CHAPTER 8

Rolling-Type Collaborative Training for False Comment Identification: Enhancing Accuracy through Multi-Characteristic Fusion

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Abstract: This research presents a false comment identification method based on rolling-type collaborative training. False comments pose a significant challenge in online platforms, impacting credibility and user experiences. The proposed method effectively utilizes unlabeled samples to assist model learning and integrates multiple characteristics, including emotion and text representation, to enhance the identification performance. The method involves obtaining comment text and determining its content characteristics, as well as obtaining reviewer information and determining their behavior characteristics. By combining these characteristics, the method performs false comment identification and outputs the identification result. Experimental results show that the proposed method achieves a 3.5% improvement in accuracy compared to traditional methods. The rolling-type collaborative training approach demonstrates the potential to enhance the reliability of comment evaluation systems and combat the spread of false information in online platforms.

Keywords: Comment text content characteristics, False comment identification, Identification performance, Multi-characteristic fusion, Model learning, Rolling-type collaborative training, Reviewer behavior characteristics.

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1. INTRODUCTION

The research presents a false comment identification method based on rolling-type collaborative training, focusing on the field of false comment identification.

The method involves a series of steps to effectively identify false comments and improve the accuracy of the identification process.

Firstly, the method acquires a comment text and determines the content characteristics of the comment based on its text. It analyzes the text to understand its features and patterns that may indicate false information.

Next, the method obtains reviewer information corresponding to the review text and determines the behavior characteristics of the reviewer based on this information. By considering the behavior patterns and history of the reviewer, the method gains additional insights into the likelihood of the comment being false.

Subsequently, the method performs false comment identification by combining the content characteristics of the comment text and behavior characteristics of the reviewer [1]. It employs a collaborative training approach that integrates multiple characteristics, such as emotion and text representation, to enhance the identification performance of the model.

Finally, the method outputs the result of false comment identification, providing a reliable indication of whether the comment is false or not [2]. Through the utilization of unlabeled samples and the integration of various characteristics, the proposed method demonstrates a 3.5% improvement in accuracy compared to traditional false comment identification methods.

2. RELATED WORKS

In the context of online shopping, consumer decision-making is often influenced by product reviews, as they provide valuable insights and help in judging the quality of a product. However, the presence of false comments poses a significant challenge to both consumers and online merchants. Dishonest merchants often resort to tactics such as posting fake positive reviews for their own products or writing false negative reviews for their competitors, creating a distorted perception of the product's quality and misleading potential customers [3 - 5]. Moreover, some merchants incentivize customers to provide positive reviews through methods like “good comment return,” where consumers are rewarded with monetary incentives for posting favorable comments and uploading pictures or videos of purchased items. These deceptive practices not only mislead potential consumers but also hinder the stable growth of e-commerce platforms [6 - 8]. It is

essential to develop an effective method for identifying false comments to ensure a trustworthy online shopping environment, provide a positive shopping experience for consumers, and gather genuine and reliable feedback.

This research focuses on addressing the issue of false comments by introducing a novel false comment identification method based on rolling-type collaborative training. The proposed method leverages unlabeled samples to enhance model learning and integrates multiple characteristics, including emotion analysis and text representation, to improve the accuracy of false comment identification. By considering both the content characteristics of the comment text and the behavior characteristics of the reviewers, the method effectively detects and identifies false comments [9 - 11].

Experimental results demonstrate that the proposed method outperforms traditional approaches, achieving a significant 3.5% improvement in identification accuracy. The rolling-type collaborative training approach proves to be a promising solution to combat the spread of false information, safeguard consumer interests, and protect the integrity of online shopping platforms [12]. By purifying the platform and promoting genuine and effective comments, the proposed method contributes to providing a reliable and transparent online shopping experience for consumers. Currently, numerous scholars both domestically and internationally have conducted research on identifying false comments [13 - 16]. JindalN *et al.* categorized false reviews based on certain criteria, such as comments solely focused on brands, comments lacking substantive content, and unrealistic comments. Their approach involved detecting duplicate comments as a means to identify false reviews. However, they did not disclose the datasets they used in their research.

Feng *et al.* delved deeper into the syntactic structure of comment content, specifically focusing on analyzing writing styles [17]. They extracted features based on context-free grammar and employed a support vector machine to classify a "golden dataset." Meanwhile, MyleOtt *et al* created a "gold" dataset for false comment recognition through an online crowdsourcing service provided by Amazon. They extracted part-of-speech characteristics by analyzing the distribution of words and utilized a characteristic set based on n-grams. Naive Bayes and support vector machines were employed as classifiers in their approach [18].

Despite these research efforts, several challenges persist in the field of false comment identification. Firstly, the prevalent use of the full-supervision framework in classification methods requires a substantial amount of labeled corpora as training data [19 - 22]. However, the scarcity of standard datasets and

CHAPTER 9

A Neural Network Study of Face Recognition

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Abstract: The difficult subject of automatic recognition has attracted a lot of interest lately since it has so many uses in so many different industries. Face recognition is one of those difficult problems, and as of right now, no method can offer a reliable response in every circumstance. A novel method for recognizing human faces is presented in this research. This method employs a two-dimensional discrete cosine transform (2D-DCT) to compress photos and eliminate superfluous data from face photographs utilizing an image-based approach to artificial intelligence. Based on the skin tone, the DCT derives characteristics from photos of faces. DCT coefficients are calculated to create feature vectors. To determine if the subject in the input picture is "present" or "not present" in the image database, DCT-based feature vectors are divided into groups using a self-organizing map (SOM), which uses an unsupervised learning method. By categorizing the intensity levels of grayscale images into several categories, SOM performs face recognition. An image database including 25 face pictures, five participants, and five photos with various facial expressions for each subject was used to complete the evaluation in MATLAB. This method's primary benefits are its high-speed processing capacity and minimal computing demands, both in terms of speed and memory use.

Keywords: Matlab, Neural network, Two-dimensional discrete cosine transform (2D-DCT).

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1. INTRODUCTION

The growing need for security as well as its potential for use in business and law enforcement have made FACE recognition a particularly active field of research in recent years. With a focus on applications including human-computer interaction (HCI), biometric analysis, content-based coding of pictures and videos, and surveillance, this field has made significant advancements during the past 10 years. Face recognition is a simple activity for the human brain, but it has proven to be quite challenging to replicate artificially.Despite certain similarities, faces differ greatly in terms of age, skin tone, gender, and hair color. Different image quality, emotions, faces, furniture, backgrounds, and lighting conditions add to the complexity of the issue. In Fig. (**1**), a recognition system is shown. The method for facial recognition presented in this work is innovative and is based on a concept put out by Hjelms and Low. They explain the preprocessing phase in their survey, which aims to separate skin-related pixels from information linked to the face. We can see the steps in Fig. (**1**).

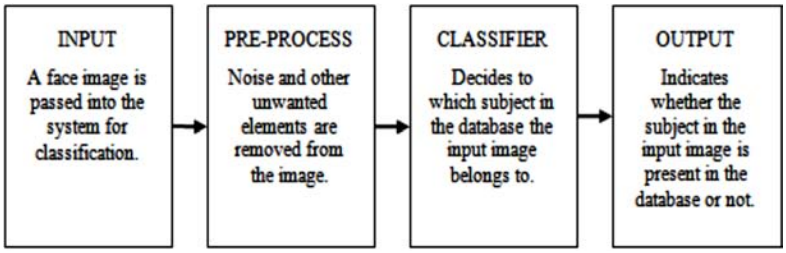

Fig. (1). A facial recognition system in a generic form.

The picture compressed by the 2D-DCT is commonly used as an intensity (grayscale) representation for additional processing during the recognition stage. Skin pixels in this grayscale rendition have intensity values. During the first step, the discrete cosine transform (DCT) coefficients are used to create feature vectors from each face image's 2D-DCT. The second step classifies data using an unsupervised learning method and a self-organizing map (SOM). By grouping vectors, the topic in the input image is “present” or “not present” in the image database. If the subject is classified as present, the best-match image from the training database is displayed as the result; if not, the result indicates that the subject cannot be found in the image database, refer to Figs. (**2** and **3**) [1].

The results of the experiments are presented in Section IV, along with suggestions for system adjustments and enhancements.

Concluding observations are included in Section V.

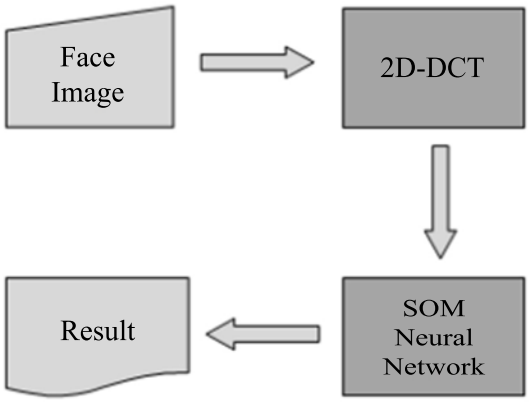

Fig. (2). Proposed facial recognition system approach.

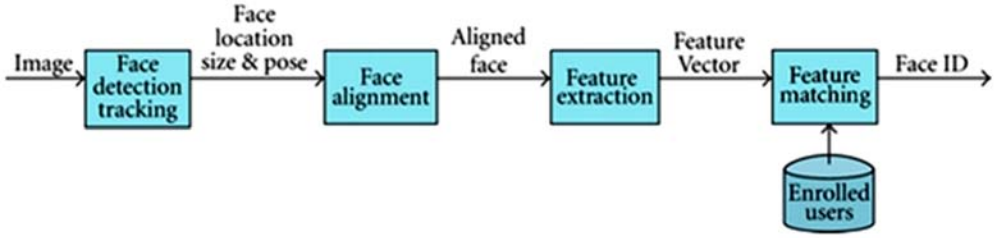

Fig. (3). A facial recognition system's structural layout.

2. FACE RECOGNITION

Face recognition is a technique that analyzes a person's facial traits to identify or confirm their identification. It is a subclass of biometric identification systems that identify people using distinctive physical or behavioural characteristics. Finding and extracting faces from an image or video frame is the initial stage in the face detection process [2]. By examining patterns, forms, and color contrasts, different algorithms are utilized to look for faces. Face Alignment: The system aligns faces by normalizing their location, size, and orientation once they have been identified. This process helps make later analyses more accurate. After that, the face's distinguishing traits are taken off. These characteristics include the relative placements of the mouth, nose, and other facial landmarks, as well as other face characteristics including texture, shape, and colour. Feature Encoding: The retrieved features are then converted into a face template or face embedding, which is a numerical representation [3]. This encoding procedure transforms the intricate facial data into a condensed and uniform representation for simpler comparison. Face Matching: The system compares the extracted face template to

CHAPTER 10

Time Sequence Data Monitoring Method Based on Auto-Aligning Bidirectional Long and Short-Term Memory Network

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Abstract: This research proposes a time sequence data monitoring method that utilizes a auto-aligning bidirectional long and short-term memory network (LSTM) for efficient and accurate monitoring of equipment. The method involves several steps, including data preprocessing, bidirectional LSTM modeling, attention scoring, prediction probability calculation, and real-time monitoring. By leveraging the capabilities of auto-aligning and bidirectional LSTM, the proposed method aims to enhance the accuracy and effectiveness of equipment monitoring based on time sequence data.

Keywords: Auto-aligning, Attention scoring, Bidirectional LSTM, Data preprocessing, Monitoring method, Prediction probability, Real-time monitoring, Time sequence data.

1. INTRODUCTION

In various domains, monitoring equipment and detecting anomalies in time sequence data are critical for ensuring operational efficiency and preventing failures. This research introduces a novel method for time sequence data monitoring based on an auto-aligning bidirectional long and short-term memory network. The proposed method leverages the advantages of auto-aligning mecha-

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nisms in capturing contextual dependencies and bidirectional LSTM in modeling temporal relationships. By combining these techniques, the method aims to improve the accuracy and efficiency of equipment monitoring. The proposed method consists of five key steps. Firstly, the time sequence data of the target equipment is collected within a predefined time period and preprocessed using a data preprocessing algorithm to convert it into a format suitable for input into the auto-aligning bidirectional LSTM network model [1 - 3]. Subsequently, the processed data is fed into the bidirectional LSTM network, where the input sequence is transformed into two eigenvectors and concatenated to obtain an output eigenvector [4, 5].

In the next step, an attention network is employed to calculate attention scores for all moments based on the output feature vector obtained in the previous step. These attention scores are then weighted and combined with the output feature vector to obtain a final output feature vector. The final step involves utilizing a fully connected classifier network to determine the prediction probability of the final output feature vector.

Additionally, the method enables real-time monitoring by acquiring time sequence data from the target equipment in non-predefined time periods. The acquired data is converted into a standard format and fed into the trained model to obtain prediction results, thereby facilitating continuous monitoring based on the auto-aligning bidirectional LSTM network [6, 7].

In various domains, such as industrial processes, healthcare, and finance, the monitoring of equipment and detection of anomalies in time sequence data play a crucial role in ensuring operational efficiency and preventing failures. This research proposes a novel method that addresses these challenges by introducing an auto-aligning bidirectional long and short term memory (LSTM) network for time sequence data monitoring [8].

The proposed method takes advantage of auto-aligning mechanisms, which allow the model to focus on important moments in the input sequence, and bidirectional LSTM networks, which capture temporal relationships in both forward and backward directions. By combining these techniques, the method aims to enhance the accuracy and efficiency of equipment monitoring [9].

The method consists of five main steps. Firstly, the time sequence data from the target equipment is collected over a specific time period. To prepare the data for the model, a data preprocessing algorithm is applied, which includes techniques such as the PauTa criterion method, standard deviation standardization, and data

division. These preprocessing steps ensure that the data is in a suitable format for input into the auto-aligning bidirectional LSTM network model. Next, the preprocessed data is fed into the bidirectional LSTM network, where the input sequence is processed in both forward and reverse directions. This allows the network to capture the temporal dependencies of the data. The output of the bidirectional LSTM network is obtained by concatenating two eigenvectors derived from the forward and reverse sequences.

In the subsequent step, an attention network is employed to calculate attention scores for each moment in the input sequence. These attention scores indicate the relative importance of each moment in contributing to the final result. The attention scores are then multiplied with the output feature vector from the bidirectional LSTM network to obtain a final output feature vector that reflects the weighted contributions of each moment [10, 11].

Finally, the final output feature vector is fed into a fully connected classifier network, which outputs a prediction probability for the given input. This probability represents the likelihood of a specific class or outcome based on the monitored data. Furthermore, the proposed method enables real-time monitoring by acquiring time sequence data from the target equipment during non-predefined time periods. This data is preprocessed using the same techniques as mentioned earlier and then input into the trained model to obtain prediction results [12]. This allows for continuous monitoring based on the auto-aligning bidirectional LSTM network.

Overall, this research proposes a time sequence data monitoring method that integrates auto-aligning and bidirectional LSTM, aiming to enhance the accuracy and efficiency of equipment monitoring. The effectiveness of the method will be demonstrated through experiments and comparative analyses, highlighting its potential contributions in various applications requiring time sequence data monitoring.

2. RELATED WORKS

Currently, in the industrial field, time series data modeling strategies can be broadly categorized into two main approaches. The first approach is mechanism modeling, where researchers utilize physical or chemical mechanisms to establish theoretical models [13]. These models aim to analyze and understand the system's behavior based on underlying mechanisms.

The second approach is data-driven modeling, which relies on real-time sensor data to establish models. In this approach, the focus is on establishing a functional relationship between the main variables (typically working condition parameters)

CHAPTER 11

Performance Evaluation of Wireless Communication System MIMO Detection Algorithms

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Abstract: Multiple Input-Multiple Output systems have been included in prominent core standards in recent decades, such as IEEE 802.11n (Wi-Fi). By increasing the number of clients at the server, Multiple Input-Multiple Output Technologies will also be used for Generation 5. Additionally, numerous gaps in the various detection methods investigated by earlier researchers have been noted. Receivers must thus develop new algorithms to make use of the satellite data to identify the sent data bits. This chapter discusses the most well-known and promising multiple input multiple output detectors as well as some surprising but fascinating ones. This study focuses on defining the many views to highlight various research methodologies, offer a basic idea, and illustrate the mathematical underpinnings of each perspective.

Keywords: FDMA, Multiple input multiple output system, Minimum mean square error, Performance complexity, 5G.

1. INTRODUCTION

The newest form of communication technology, massive multiple-input multiple-output (MIMO), satisfies these needs. In massive MIMO, the base station is connected to several antennas to support hundreds or tens of users accessing resources simultaneously and at the same frequency, while also delivering notably greater connection dependability and energy efficiency.

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To do this, more complications of linear algorithms need to be resolved, which reduces base station complexity and cost. Additionally, the maximum likelihood (ML) detection method is the best in multi-user scenarios. However, it suffers from increasing complexity as consumers increase, and the size of the constellation also influences the exponential complexity, making the ML detector useless for numerous antennas [1].

These systems can perform well as (ML), but because of their computational complexity, they cannot be used when channel measurements are very extensive, especially when massive MIMO is involved. The advantages of linear detection techniques like ZF (zero-forcing) and MMSE (minimum mean square error) are clear due to their higher performance/difficulty trade-offs. However, even linear detectors for vast MIMO systems may be too complex since they require the inversion of large matrices. For a 16-user large MIMO system, a 16 * 16 matrix inversion is required [2, 3]. The AMIMO (Multiple-Input Multiple-Output) system is chosen based on the region's or area's consumer demand for the MIMO system to serve everyone in that area without any interruption or delay (Figs. **1** and **2**).

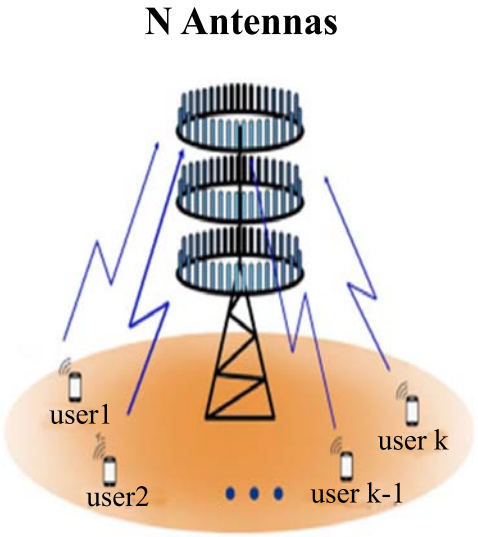

Fig. (1). Multiple antennas (N) and multiple users (K) MIMO system [1].

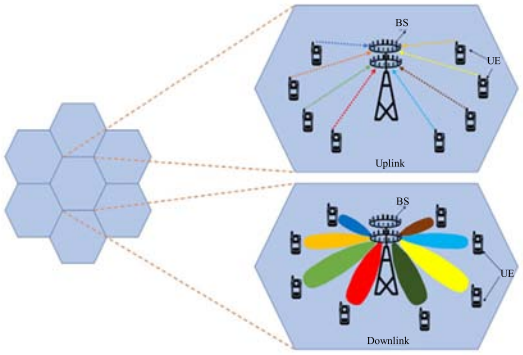

Fig. (2). Uplink and downlink of massive MIMO [7].

2. SISO, SIMO, MISO, AND MIMO TERMINOLOGY

Outputs for the different antenna technology combinations might be single or numerous. They must communicate over the radio. In this instance in particular, the transmitter serves as the system's source by delivering the signal to the link or signal path, while the receiver serves as the signal's reception. It is at the Wi-Fi connection's end [4].

The various single and multiple antenna connection types are so explained as follows:

1. SISO or Single Input Single Output is based on just one output. It describes a system or a channel with only one input signal and just one corresponding output signal. It alludes to a method or it is described as a system or channel having a single input signal and a single output signal that is directly related to it.

2. SIMO or Single Input Output Multiple Outputs. SIMO systems create many output signals from a single input signal.

3. MISO, or Multiple Input, Single Output. Multiple input signals are present in MISO systems, but only one output signal is produced.

4. MIMO—Multiple Input Multiple Output. Multiple input signals and multiple output signals are produced in MIMO systems.

2.1. SISO Systems

The abbreviation SISO is frequently used in the fields of communication systems and information theory. The acronym SISO means “Single Input, Single Output.”

CHAPTER 12

Design and Implementation of a Clock Generator Based on All Digital PLL (ADPLL)

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Abstract: Every electronic circuit now includes a clock, which is essential because it regulates the speed and efficiency of electronic circuits. The need for reliable and accurate clock generation mechanisms in the circuits thus increases. There are two ways to generate a clock. The first option is to use a crystal oscillator, which gives the circuit a fixed clock. However, if different clocks are required in separate system components, we must use several crystal oscillators, which increases the circuit's size and complexity. The second choice is to employ a phase-locked loop (PLL) clock generator system, which allows us to produce precise and wide-ranging clocks for the various components of the system or circuit by utilizing dividers and multipliers. Digital methods are used in the design and implementation of a clock generator based on an All-Digital Phase-Locked Loop (ADPLL) to provide reliable and precise clock signals. ADPLLs are appealing substitutes for conventional analog PLLs because they have better noise immunity, are scalable, and are simple to integrate into digital systems. In this project, a method for all digital phase-locked loops (ADPLL) that solely makes use of digital cell libraries is demonstrated. For use in digital circuits, this ADPLL is intended to create a broad frequency range. The suggested ADPLL is portable for different processes and ideal for SoC applications since it can be implemented using standard cells. It will be created using MATLAB Simulink modeling, and then it will be put into use on an XILINX FPGA. An ADPLL clock generator's design and implementation process generally includes the following steps:

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The appropriate clock frequency range, stability criteria, phase noise specifications, power consumption restrictions, and other performance factors should all be determined. Architecture Selection: Based on the system requirements and trade-offs, select a suitable ADPLL architecture. The advantages and disadvantages of various designs, such as Bang-Bang, Sigma-Delta, and Delay-Locked Loop (DLL), vary. Designing the ADPLL's separate parts, such as the PFD, DLF, NCO, and frequency divider, is known as component design. Designing digital circuitry and algorithms to carry out the necessary operations is required. Simulation and Verification: To verify the ADPLL design's performance, functionality, and stability, specialized software tools are used. If required, we change the design parameters. Layout and Physical Design: Create a hardware description language (HDL) implementation of the ADPLL design and layout and design the circuitry physically. This takes into account factors like power distribution, noise reduction, and signal integrity. Integration and testing: The ADPLL design should be integrated into the larger system, connected to the reference clock source, and tested thoroughly to ensure that it operates as expected under a variety of circumstances. The ADPLL design should be tweaked to improve performance, such as by lowering power consumption, jitter performance, or lock time.

Keywords: Connected and autonomous vehicles (CAVs), Cyber security, Federated learning, Vehicular network.

1. INTRODUCTION

One of the most often utilized circuits for supplying clocks in digital systems is the phase-locked loop. A PLL was traditionally created as an analog building component. In a digitally noisy system-on-chip (SoC) environment, using an analog PLL leads to challenging integration and interfacing problems. Recent nanometer-scale CMOS technologies, which have weak analog extensions and limited voltage headroom, are insufficient for integrating complex analog functionalities. ADPLLs include numerous essential parts, including the PFD that examines the phase and frequency differences between the feedback clock signal and the reference clock signal. Based on the phase difference, control signals are produced. The DLF transforms the PFD control signals into a digital control word that modifies the output clock's phase and frequency. The NCO produces a continuous waveform with a frequency proportionate to the digital control word from the DLF. It is a digitally controlled oscillator. The frequency Divider provides the required clock frequency, and the frequency divider splits the NCO's output clock signal [1 - 3].

The analog route is severely degraded by the switching noise of large digital circuits, and frequency tuning is made extremely difficult by the new MOS transistors' highly nonlinear C_V characteristics. The analog PLL must also be rebuilt for every new technology since it is sensitive to process conditions. Clock generators or digital-controlled oscillators (DCO) will undoubtedly perform worse but are considerably simpler to construct as they do not focus on a particular

technology. DCO is the most significant element of such clocking circuits since it predominates the key ADPLL characteristics, such as power consumption and jitter. Since DCO consumes more than 50% of an ADPLL's power, it needs to be further diminished to conserve total power dissipation and satisfy low-power requirements in SoC designs [4, 5].

It will scale well with technology if an entirely digitally controlled PLL is constructed using only active parts, such as transistors. Analog circuit components like capacitors and resistors would not match with technological advancements in the same way. A PLL with standardized digital CMOS components (standard cells) is simple to construct using any CMOS technology, which can significantly shorten the time it takes for a design to reach the market. Additionally, a digital HDL simulator may be used to simulate systems that include the PLL if the complete PLL is written in an HDL language [6, 7].

The oscillator, which must be modeled as an analog component to provide accurate estimations of its behavior, is the crucial component for a PLL manufactured using conventional cells. The absence of nonlinear feedback loops makes it considerably easier to simulate an oscillator than a PLL. The primary goal of this effort is to decrease the complexity of digital PLL design to that of oscillator design as we can see in Fig. (**1**).

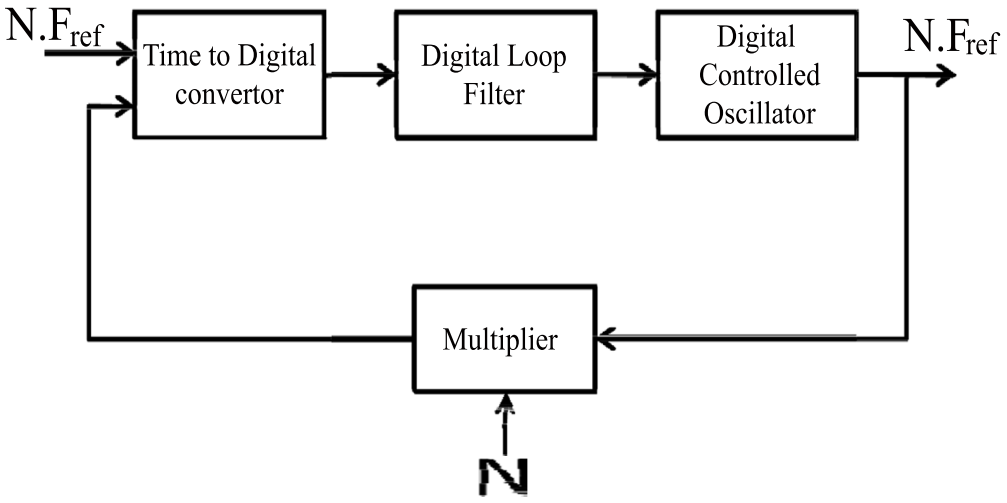

Fig. (1). ADPLL block structure.

2. ELECTRIC LOOP FILTER

A typical component in digital control systems, especially in the areas of digital signal processing and digital communication systems, is a digital loop filter. It is a

CHAPTER 13

Three-Dimensional Point Cloud Initial Enrollment Algorithm Based on Centre-of-mass and Centering

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Abstract: This research presents a novel algorithm for the initial enrollment of three-dimensional point clouds, addressing the issue of accuracy enrollment algorithms, such as the Iterative Closest Point (ICP), being prone to local optima in point cloud enrollment. The proposed method employs a filtering technique to preprocess the point cloud data, followed by establishing an angular shift model using the centre-of-mass and mass center of the point cloud data. An iterative rotation model is then constructed to determine the optimal angular shift, enabling the completion of the initial enrollment. Furthermore, the effectiveness of the initial enrollment algorithm is validated by comparing it with the conventional center-of-gravity-based initial enrollment method, along with a subsequent accuracy enrollment using the ICP algorithm. Comparative experiments demonstrate the superior performance of the proposed algorithm in terms of initial enrollment effectiveness.

Keywords: Angular shift model, Centre-of-mass, Centering, Iterative Closest Point (ICP), Initial enrollment, Three-dimensional point clouds.

1. INTRODUCTION

Three-dimensional point cloud enrollment plays a crucial role in various applications, including robotics, computer vision, and autonomous navigation. The process involves aligning multiple point clouds acquired from different sen-

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sors or viewpoints to establish a coherent and accurate representation of the observed environment [1 - 3]. The Iterative Closest Point (ICP) algorithm is widely used for point cloud enrollment due to its simplicity and effectiveness. However, one major challenge faced by ICP and similar enrollment algorithms is the susceptibility to local optima, which can lead to inaccurate enrollment results [4]. To address this issue, this research introduces a novel algorithm for the initial enrollment of three-dimensional point clouds. The proposed algorithm leverages the concepts of center-of-mass and centering to enhance the accuracy and robustness of the initial enrollment process [5, 6].

To validate the effectiveness of the proposed initial enrollment algorithm, a comparative experiment is conducted with the conventional method based on the centre-of-mass. Additionally, the algorithm is further evaluated through subsequent accuracy enrollment using the widely adopted ICP algorithm [7]. The results demonstrate that the initial enrollment effect achieved by the proposed algorithm surpasses that of the center-of-gravity-based method, indicating superior performance in terms of accuracy and enrollment quality [8, 9].

In summary, this research presents a novel approach to improve the initial enrollment of three-dimensional point clouds [10]. By leveraging the centre-o--mass and centering, the algorithm overcomes the limitations of traditional enrollment methods and provides a more robust and accurate solution [11]. The subsequent verification and comparison with existing techniques reinforce the efficacy of the proposed algorithm, making it a valuable contribution to the field of point cloud enrollment.

2. RELATED WORKS

The advancement of three-dimensional point cloud scanning techniques has led to a significant progress in various fields such as reverse engineering, 3D printing, and commercial measurements [12, 13]. Point cloud enrollment, which involves aligning multiple point clouds from different viewpoints to create a comprehensive three-dimensional model, is a fundamental and crucial problem in dimensional modeling technology [14]. The Iterative Closest Point (ICP) algorithm is widely used for point cloud enrollment due to its effectiveness [15]. However, the ICP algorithm often faces challenges when dealing with point clouds that have significant initial position differences, leading to convergence on suboptimal solutions [16]. Therefore, the initial enrollment of point clouds, also known as rough enrollment, becomes a critical step in the enrollment process. Achieving high enrollment accuracy during this initial step is essential for subsequent refinement and accurate modeling.

Currently, various algorithms are available for point cloud initial enrollment. These algorithms can be categorized into approaches based on geometric feature description (*e.g.*, Fast Point Feature Histograms, FPFH) [17], global search strategies (*e.g.*, Four Point Congruent Sets, 4PCS), statistical probability (*e.g.*, Normal Distributions Transform, NDT), and centre-of-mass coincidence method [18]. The centre-of-mass coincidence method involves aligning point clouds by simply overlapping their centre-of-mass [19]. While this method can reduce translation errors, it fails to address rotation errors, resulting in lower precision in the initial enrollment process. As a result, the centre-of-mass coincidence method does not meet the requirements for accurate initial enrollment and is less commonly used in practical applications.

To overcome the limitations of existing methods and improve the initial enrollment of point clouds [20], this research proposes a novel algorithm based on the centre-of-mass and centering [21]. The algorithm aims to filter the point cloud data to remove junk data before establishing a angular shift model using the centre-of-mass and mass center of the point cloud data [22]. An iterative rotating model is then developed to find the optimal angular shift, enabling more accurate initial enrollment.

In order to validate the effectiveness of the proposed algorithm, comparative experiments are conducted, comparing it with the conventional center-of-gravi-y-based initial enrollment method [23, 24]. Additionally, the proposed algorithm is evaluated through subsequent accuracy enrollment using the widely used ICP algorithm [25]. The results demonstrate that the initial enrollment effect achieved by the proposed algorithm surpasses that of the center-of-gravity-based method, indicating superior performance in terms of accuracy and enrollment quality [26]. This research addresses the challenges in the initial enrollment of three-dimensional point clouds by introducing a novel algorithm based on the centre-o--mass and centering [27]. By considering both translation and rotation, the proposed algorithm improves the accuracy and robustness of the initial enrollment process. The comparative experiments and evaluation with existing methods confirm the superiority of the proposed algorithm, making it a valuable contribution to the field of point cloud enrollment.

3. RESEARCH METHODOLOGY: A THREE-DIMENSIONAL POINT CLOUD INITIAL ENROLLMENT ALGORITHM

The present research addresses the challenge of local optimum trapping in accuracy enrollment algorithms like ICP in three-dimensional point cloud enrollment. To overcome this issue, a novel three-dimensional point cloud initial enrollment algorithm based on centre-of-mass and centering is proposed [28, 29].

CHAPTER 14

Multi-Resolution Image Similarity Learning: A Method for Extracting Comprehensive Image Features

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Abstract: This research presents an image similarity learning method that focuses on extracting multi-resolution features from images. The proposed method involves a series of steps, including image collection, normalization processing, image pairing based on visual judgment and a Hash algorithm, and division of data into training and testing sets. Furthermore, a network model is constructed using a deep learning framework, and a specific objective function and optimizer are designated for similarity learning. The network model is then trained and tested using the prepared data sets. This method addresses several challenges encountered in conventional image similarity learning, such as limited feature information extraction, inadequate description of image features, limitations imposed by data volume during network training, and susceptibility to overfitting.

Keywords: Deep learning, Data set division, Image similarity learning, Multi-resolution features, Network model, Overfitting.

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1. INTRODUCTION

The extraction of comprehensive and informative features from images plays a crucial role in various computer vision tasks, including image similarity learning [1]. The conventional approaches to image similarity learning often face limitations in accurately describing image features, restricted data volume for network training, and the generation of overfitting [2]. To overcome these challenges, this research presents a novel image similarity learning method that focuses on extracting multi-resolution features from images [3]. The proposed method begins with the collection of chip card slot images using a laboratory industrial camera. To enhance the quality and comparability of the images, a normalization process is applied. Leveraging human visual judgment and a Hash algorithm, the images are combined into spectral image-image pairs based on their similarity or dissimilarity. This pairing process forms an input image pair data set, which is subsequently divided into a training set and a testing set. To construct an effective network model for similarity learning, a deep learning framework is selected [4]. The network training objective function and optimizer are carefully designated to facilitate the learning of similarity relationships between images. The network model is trained using the prepared training set and then evaluated on the testing set to assess its performance.

The research introduces a novel multi-resolution image similarity learning method to address the limitations observed in conventional approaches [5]. Traditional methods often offer the extraction of single-feature information, which hinders their ability to capture the full complexity of image content. Moreover, these methods often lack the descriptive power required to accurately represent image features, leading to suboptimal similarity matching [6]. Additionally, the reliance on limited training data poses challenges in achieving robust and generalizable models, while the risk of overfitting restricts the network's adaptability [7]. By adopting this multi-resolution image similarity learning method, the research aims to overcome the limitations of conventional approaches. These include the extraction of single-feature information, insufficient description of image features, restricted training due to limited data volume, and the tendency to generate overfitting [8, 9]. By capturing multi-resolution features, the proposed method seeks to provide a more comprehensive representation of image characteristics and enhance the accuracy and effectiveness of image similarity learning. In the subsequent sections, the methodology of the proposed approach will be detailed, followed by experimental results and analysis to demonstrate the effectiveness and reliability of the method [10]. The research concludes with discussions on the significance of the findings and potential avenues for further exploration in the field of image similarity learning.

2. RELATED WORKS

Image similarity learning plays a crucial role in various applications such as face recognition, image camouflage evaluation, image retrieval, image quality evaluation, and pedestrian recognition. It involves characterizing the correlation between images by mining their content information [11, 12]. Traditional machine learning methods for image similarity rely on calculating distances between feature vectors, utilizing metrics like cosine distance and Euclidean distance. They also employ techniques like Structure Similarity (SSIM) and manually defined feature descriptors to represent image similarity [13]. However, these approaches often suffer from limitations due to their complex processes and insufficient extraction of image feature information. The advancement of deep learning technology has paved the way for a more effective approach to image similarity learning [14]. Deep learning networks can learn image similarity by automatically extracting feature information based on a self-learning priori condition [15]. Various network architectures have been developed for this purpose, including twin networks (Simense network), two-branch networks (Two-branch), two-channel networks (Two-channel), and supervised [16] deep learning neural networks for learning perception distances.

By adopting a supervised learning mode, deep learning networks eliminate the need for manually designing feature descriptors, reducing complexity and increasing efficiency [17]. However, the current stage of research on image similarity learning based on deep learning [18] networks faces certain challenges. One of the main issues is that the image feature information extracted by these networks tends to be limited to a single feature, which may not accurately describe the diverse characteristics of an image [19]. Consequently, the accuracy of similarity matching is compromised. Additionally, network training is often constrained by the size of the available data, and overfitting, where the model becomes too specialized for the training data, is a common concern.

To address these challenges, this research proposes an image similarity learning method that focuses on extracting multi-resolution features from images [20]. The method consists of several steps to accomplish this goal. In the first step, chip card slot images are collected using a laboratory industrial camera [21, 22]. These images undergo normalization processing to ensure consistent data representation. To enhance the extraction of image features, pairs of similar or dissimilar single images are combined into spectral images [23, 24]. This combination is achieved through human visual judgment and a Hash algorithm that quantifies the similarity or dissimilarity of the images. The resulting input image pairs form a dataset that is subsequently divided into a training set and a test set.

CHAPTER 15

Tensor Singular Value Decomposition-Based Multiple View Spectral Segmentation

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Abstract: This research presents a novel approach called "Multiple View Spectral Segmentation based on Tensor Singular Value Decomposition" for the segmentation of multi-view data. The algorithm utilizes three-rank tensors and constructs a probability transfer matrix for all view data. By exploiting the low-rank nature of tensors in the lateral, longitudinal, and vertical directions, the proposed procedure characterizes the tensor's low-rank properties in each dimension using a multi-rank approach based on tensor singular value decomposition (Tensor-SVD). Tensor-SVD decomposition, being based on tube convolution, enables the model to capture spatial correlations more effectively compared to other tensor resolution techniques and procedures based on two-dimensional structure relationships. Furthermore, the use of Fourier transformation allows for efficient calculations, thereby improving computational efficiency. Experimental results demonstrate that the proposed tensor resolution model based on Tensor-SVD achieves improved segmentation performance for multiple-view data.

Keywords: Computational efficiency, Fourier transformation, Low-Rank characterization, Multiple view spectral segmentation, Multi-rank tensor, Probability transfer matrix, Spatial correlation, Tensor singular value decomposition.

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1. INTRODUCTION

In recent years, the increasing availability of multi-view data has posed new challenges and opportunities in various domains, including computer vision, machine learning, and data analysis [1 - 3]. Multi-view data refers to datasets that consist of multiple perspectives or modalities of the same underlying objects or phenomena [4]. Examples of multi-view data include images captured from different angles, sensor readings from different sensors, or text documents with different representations. The analysis and segmentation of such multi-view data are essential for gaining comprehensive insights and extracting meaningful patterns [5].

Traditional segmentation procedures, designed for single-view data, often fail to fully exploit the complementary information present in multi-view data [6 - 8]. These procedures typically treat each view independently, ignoring the correlations [9] and dependencies that exist among the different views. As a result, the segmentation performance may be suboptimal, and valuable information may be overlooked.

To address these limitations, researchers have proposed various approaches for the segmentation of multi-view data [10 - 12]. One promising direction is spectral segmentation, a popular technique that leverages the eigen structure of similarity matrices to partition data into cohesive groups [13]. Spectral segmentation has shown great success in single-view segmentation tasks and has been widely adopted in various applications [14]. However, directly applying spectral segmentation to multi-view data faces challenges due to the lack of a unified representation that captures the correlations among different views [15]. In this research, we propose a novel procedure called “Multiple View Spectral Segmentation based on Tensor Singular Value Decomposition” to address the segmentation problem in multi-view data [16 - 18]. The key idea is to represent the multi-view data as three-rank tensors and leverage the tensor singular value decomposition [19] (Tensor-SVD) to characterize the low-rank structures in each dimension. By doing so, we can effectively capture the correlations among different views and enhance the segmentation performance [20]. The Tensor-SVD decomposition [21], which is generated based on tube convolution, offers several advantages for the segmentation multi-view data [22 - 25].

Firstly, it provides a more expressive representation that can fully exploit the spatial structure and correlations inherent in the multi-view data [26]. Unlike traditional two-dimensional approaches that may overlook certain structural dependencies, Tensor-SVD [27, 28] considers the low-rank properties in the lateral, longitudinal, and vertical directions simultaneously [29]. This

comprehensive representation allows for a more accurate and robust segmentation of the multi-view data.

Secondly, the use of Fourier transformation in the Tensor-SVD framework enables efficient computations [30]. This is particularly advantageous when dealing with large-scale multi-view datasets, where computational efficiency is crucial [31]. By leveraging Fourier transformation, we can accelerate the calculations involved in the Tensor-SVD decomposition and achieve faster segmentation performance without sacrificing accuracy [32 - 35], as shown in Fig. (**1**).

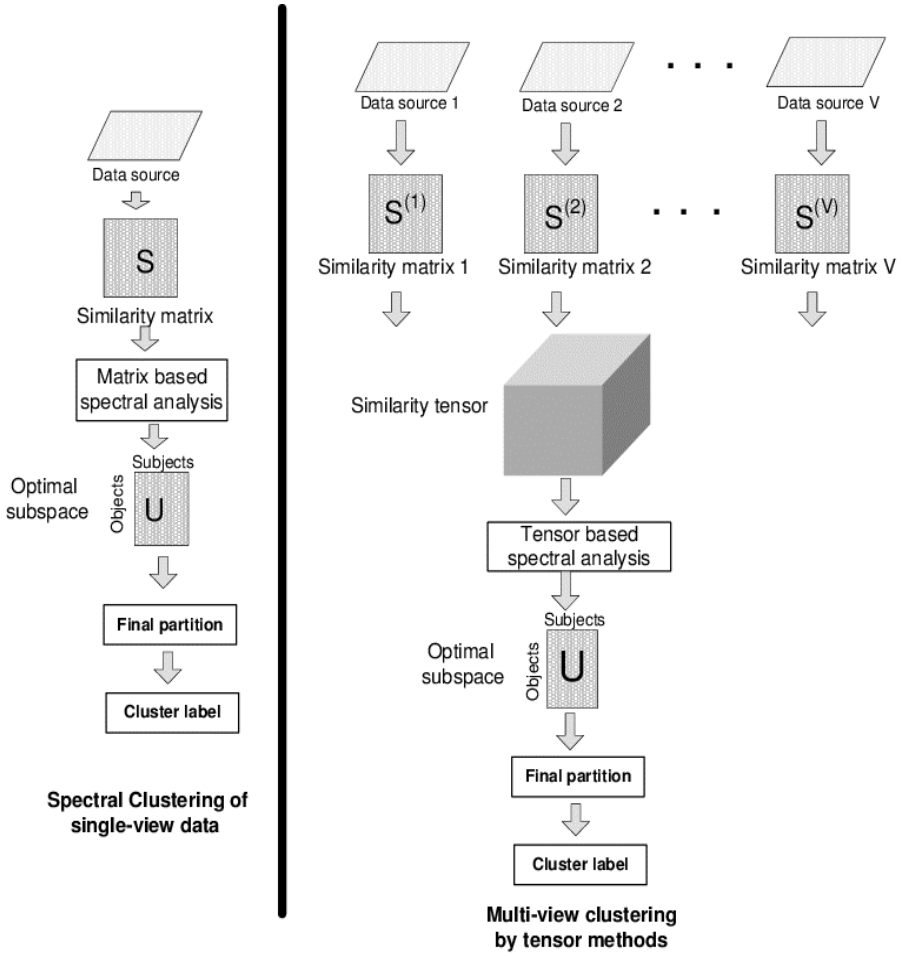

Fig. (1). Comparison between unimodal (left) and multimodal (right) spectral segmentation.

CHAPTER 16

Enhanced CNN-Based Failure Integrated Assessment Procedure for Energy Accumulator Packs

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Abstract: This research presents a failure-integrated assessment procedure and structure for energy accumulator packs using an enhanced Convolutional Neural Network (CNN). The proposed approach involves wavelet packet decomposition processing of voltage change and State of Charge (SOC) signals from a lithium accumulator to extract energy values as input features. The assessment network performs a preliminary failure assessment on the energy accumulator pack, followed by evaluating whether the preliminary assessment result satisfies the assessment confirmation condition. If met, an assessment result for the energy accumulator pack is obtained. Otherwise, an auxiliary assessment using a CNN network is conducted for further analysis. The primary assessment result and auxiliary assessment result are then fused using the D-S evidence theory procedure to generate a comprehensive integrated assessment result. Finally, the integrated assessment result is evaluated, and the ultimate assessment result is determined. The proposed procedure improves the assessment accuracy of energy accumulator packs by enhancing the structure of the CNN network, determining the optimal size of the convolution kernel based on the Bayesian Information Criterion (BIC), and incorporating auxiliary assessment networks for enhanced accuracy and integrated assessment.

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Keywords: Assessment confirmation, Auxiliary assessment, Accuracy improvement, Convolutional neural network (CNN), D-S evidence theory, Energy accumulator pack, Failure assessment, Integrated assessment, State of charge (SOC), Wavelet packet decomposition.

1. INTRODUCTION

Energy accumulator packs play a crucial role in various applications, such as electric vehicles and renewable energy structures [1], as they provide the necessary energy storage capacity. However, the occurrence of failures in energy accumulator packs can lead to reduced performance [2], safety concerns, and even structure failures. Therefore, it is essential to develop effective failure assessment procedures to ensure the reliable operation of these accumulator packs [3]. In recent years, deep learning techniques [4], particularly Convolutional Neural Networks (CNNs) [5], have shown remarkable capabilities in various domains, including image recognition, natural language processing, and medical assessment. These techniques have also demonstrated promising potential in failure assessment applications. By leveraging the energy feature extraction and pattern recognition capabilities of CNNs [6, 7], accurate and efficient failure assessment can be achieved.

In this research, we propose an enhanced CNN-based failure-integrated assessment procedure and structure for energy accumulator packs. The objective is to enhance the failure assessment accuracy and reliability, ensuring the optimal performance and safety of the accumulator packs. The proposed procedure combines the advantages of wavelet packet decomposition, preliminary assessment, auxiliary assessment, and integrated assessment using the D-S evidence theory.

The failure assessment process begins by conducting wavelet packet decomposition on the voltage change signal and State of Charge (SOC) change signal of a lithium accumulator [8]. This decomposition step helps extract valuable energy-related information, which is used to form an input feature vector. The CNN-based assessment network then performs a preliminary assessment of the failures present in the energy accumulator pack using the extracted features. To ensure the reliability of the assessment, the preliminary assessment result is evaluated against an assessment confirmation condition. If the condition is met, an assessment result of the energy accumulator pack is obtained. However, if the failure does not meet the assessment confirmation condition, an auxiliary assessment is carried out using an additional CNN network. This auxiliary assessment step provides further insights and analysis into the energy accumulator pack failure.

To integrate the preliminary assessment and auxiliary assessment results, an integrated assessment is performed using the D-S evidence theory procedure. This integrated process combines the individual assessment outcomes and leverages their strengths to generate a comprehensive and reliable assessment result. By considering multiple perspectives and information sources, the integrated assessment enhances the overall accuracy and robustness of the failure assessment process. One of the key contributions of this research lies in the improvement of the CNN network structure [9]. Specifically, the optimal size of the convolution kernel in the convolutional layers is determined based on the Bayesian Information Criterion (BIC). This optimization approach helps enhance feature extraction capabilities of the CNN, leading to a more effective failure assessment.

The proposed procedure and structure aim to address the limitations and challenges associated with energy accumulator pack failure assessment. By integrating wavelet packet decomposition, preliminary assessment, auxiliary assessment, and integrated assessment, along with the enhanced CNN structure, we expect to achieve significant improvements in failure assessment accuracy and reliability. In summary, this research presents a comprehensive approach to energy accumulator pack failure assessment. The combination of wavelet packet decomposition, preliminary assessment, auxiliary assessment using CNNs, and integrated assessment using the D-S evidence theory offers a robust and accurate solution. The utilization of an enhanced CNN network structure further enhances the failure assessment accuracy [10]. The experimental results and performance evaluations presented in this study will demonstrate the effectiveness and potential of the proposed procedure in improving the failure assessment of energy accumulator packs.

2. RELATED WORKS

In recent years, the adoption of lithium-ion batteries has significantly increased due to their numerous advantages, such as high voltage, high cycle number, high energy density, and environmental friendliness. However, ensuring the safe and reliable operation of lithium-ion batteries remains a critical challenge. In Asia, the lithium-ion accumulator technology is still not fully mature, and the initial failure characteristics of accumulator packs may exhibit inconsistency, making it difficult to detect failures. Inconsistency in lithium-ion accumulator packs refers to the significant deviation in parameters such as capacity, internal resistance, and voltage among batteries of the same type and specification. This inconsistency can lead to issues such as overcharging, over-discharging, compromised safety, and reduced service life of the accumulator pack [11]. Therefore, it is crucial to develop effective failure assessment procedures for lithium-ion accumulator packs.

CHAPTER 17

Fine Granularity Conceptual Model for Bilinearity Fusion Features and Learning Methods in Multilayer Feature Extraction

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Abstract: This research presents a novel approach for fine granularity image analysis by combining bilinearity fusion features and learning methods. A depth convolutional network model, VGG16, is utilized to extract multilayer features from the fine granularity images. The proposed method involves the fusion of features extracted from VGG-16conv4_1, VGG-16conv4_2, and VGG-16conv4_3 using bilinear feature descriptors. The fused features are then fed into a softmax-based multi-class classifier to obtain classification results. The preprocessing phase involves data enhancement techniques such as subtracting image mean value, noise elimination, random cropping, and image level overturning. By leveraging the fusion of fine granularity image multilayer features, the proposed approach enhances classification precision even with only image-level classification information.

Keywords: Bilinearity fusion features, Bilinear feature descriptor, Classification, Conceptual model, Data preprocessing, Depth convolutional network, Fine granularity, Image analysis, Learning methods, Multilayer feature extraction, VGG16.

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1. INTRODUCTION

Fine granularity image analysis plays a crucial role in various domains, including computer vision, pattern recognition, and image processing. The ability to extract meaningful features from fine granularity images and accurately classify them is a challenging and essential task. This research presents a novel approach that combines bilinearity fusion features and learning methods to tackle this challenge.

In this study, a depth convolutional network model known as VGG16 is employed to extract multilayer features from fine granularity images. The VGG16 model is widely recognized for its effectiveness in image analysis tasks. The proposed method focuses on fusing features obtained from specific layers of the VGG16 model, namely VGG-16conv4_1, VGG-16conv4_2, and VGG-16conv4_3, using bilinear feature descriptors [1].

By incorporating bi-linearity fusion features, the aim is to capture complex relationships and interactions between the different layers of the network. This fusion process enables the extraction of more comprehensive and discriminative features from the fine granularity images, leading to improved classification accuracy.

To obtain the final classification results, the fused features are fed into a softmax-based multi-class classifier [2, 3]. This classifier leverages the combined feature representation to accurately classify the fine granularity images into various classes or categories. In addition to the feature fusion and classification steps, the research also addresses the crucial phase of data preprocessing [4 - 6]. This phase involves several techniques to enhance the quality and relevance of the input image data. These techniques include subtracting the image mean value to eliminate noise, as well as applying data augmentation methods such as random cropping and image level overturning [7]. One notable advantage of the proposed approach is that it achieves improved classification precision even when provided with only image-level classification information. By exploiting the fusion of fine granularity image multilayer features, the research aims to overcome the limitations of traditional methods that solely rely on image-level information for classification tasks. Overall, this research contributes a novel conceptual model that integrates bi-linearity fusion features and learning methods for fine granularity image analysis. The experimental evaluation of the proposed approach demonstrates its effectiveness in enhancing classification accuracy and provides insights into the potential applications of this model in various fields that require fine granularity image analysis [8].

2. RELATED WORKS

Fine granularity image classification, also known as fine-grained categorization or subclass image classification, has gained significant popularity in fields such as computer vision and pattern recognition in recent years [9, 10]. This research focuses on the meticulous study of fine granularity image classification, aiming to achieve more accurate and refined classification results. The primary motivation behind conducting fine granularity image classification is to provide a more detailed and nuanced categorization beyond coarse-level classification. Fine granularity images often possess subtle differences that contribute to refined classification, and these differences are typically localized to specific regions within the image. In contrast to tasks like face recognition [11], where the differences between classes are more apparent, fine granularity image classification presents greater challenges due to factors such as varying poses, illumination conditions, scales, and complex backgrounds. Consequently, fine granularity image classification represents a highly challenging task [12].

The significance of fine granularity image classification extends to both academia and industry, with extensive research efforts and diverse application scenarios. Industries and academia alike have a vested interest in identifying different subclasses within various domains, such as birds, dogs, flowers, vehicles, and aircraft [13, 14]. In real-life applications, the accurate identification of different subclasses is vital for ecological studies, as it serves as a crucial prerequisite for effective ecological protection. If computer vision technology can enable low-cost fine granularity image recognition, it would hold immense importance for both academic research and industrial applications. Overall, fine granularity image classification is a challenging and important research area due to its wide-ranging applications and the complexities associated with distinguishing subtle differences within images. By advancing the technology of computer vision and exploring novel approaches such as bilinearity fusion features and learning methods [15], this research aims to contribute to the progress of fine granularity image classification and facilitate its application in various domains. Fine granularity image classification, also known as fine-grained categorization or subclass image classification, has gained significant popularity in fields such as computer vision and pattern recognition in recent years. This research focuses on the meticulous study of fine granularity image classification, aiming to achieve more accurate and refined classification results.

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CHAPTER 18

From Chips to Systems: Exploring Disruptive VLSI Ecosystems

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Abstract: This chapter provides an insightful exploration of the evolution and disruptive impact of Very Large Scale Integration (VLSI) technology. The work traces the development of VLSI from the integration of a few transistors to the intricate ecosystem of today, highlighting notable developments in architectural innovations, system-level design, and process technology. The growing impact of neuromorphic circuits in the VLSI environment is highlighted. In addition to discussing the difficulties the field faces, from scale constraints to design complexity, it also provides an outlook of the future by speculating on the potential of quantum computing, Artificial Intelligence (AI) driven design and ethical issues. The narrative underscores the imperative of innovation, collaboration, and interdisciplinary approaches to navigate the dynamic realm of VLSI, promising a future where VLSI continues to revolutionize technology and shape our world.

Keywords: Complementary metal oxide semiconductor (CMOS), Low power, Neuromorphic circuit, System-on-Chip (SoC), VLSI.

1. INTRODUCTION

The world of technology is continually evolving, and at the heart of this evolution lies the field of VLSI (Very Large Scale Integration) design. VLSI technology has seen remarkable advancements over the years, transforming from the integration of a few transistors to billions of them on a single chip [1]. This rapid growth has not only impacted the semiconductor industry but has also disrupted various sectors, influencing the way we live, work, and communicate.

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Satvik Vats, Vikrant Sharma, Dibyahash Bordoloi & Satya Prakash Yadav (Eds.)

In this chapter, we delve into the disruptive nature of VLSI technology, particularly focusing on how it has transcended from the realm of individual chips to the broader domain of systems. We'll explore the trends, innovations, and implications of this shift, shedding light on the transformative potential of VLSI in shaping our future.

2. THE EVOLUTION OF VLSI: A BRIEF OVERVIEW

The transistor was a revolutionary breakthrough in the late 1950s and early 1960s, when VLSI first emerged. Discrete component assembly, which was used in this era to create electronic circuits, involved employing individual transistors, resistors, and capacitors. However, there were drawbacks to this strategy, chiefly related to size, power consumption, and dependability. The journey of modern VLSI can be summarized as follows:

1. Birth of the Integrated Circuit (IC): The first functional integrated circuit was demonstrated by Texas Instruments designer Jack Kilby in 1958, marking a significant milestone in the field. His work entailed creating a whole electrical circuit from a single semiconductor component. A few months later, Fairchild Semiconductor co-founder Robert Noyce created a comparable technique that finally developed into the planar process, which enables the integration of many components onto a single silicon wafer [2].
2. Moore's Law and Scaling: Co-founder of Intel Gordon Moore noticed a pattern in the 1960s: the number of transistors on a chip was roughly doubling every two years. This finding, which is well-known as Moore's Law, served as the semiconductor industry's compass. Scientists and engineers worked to minimize the size of transistors and other chip components, which enhanced functionality, decreased prices, and improved performance [3].
3. VLSI Emergence: The amount of transistors that could be integrated into a chip grew tremendously as technology developed. The integration of hundreds of thousands to millions of transistors on a single chip gave rise to the term “VLSI”. VLSI technology greatly increased processing power and made it possible to create previously unthinkable sophisticated systems [4]
4. The Microprocessor Revolution: The development of the microprocessor was one of the most important turning points in the history of VLSI. With around 2,300 transistors, Intel's 4004 microprocessor was the first to be sold commercially in 1971. This invention transformed computing, ushering in the era of personal computers and having an impact on several other sectors [5].
5. Continued Miniaturization and Modern VLSI: Miniaturization continued to be pushed to new limits by developments in lithography and semiconductor fabrication techniques. Transistor sizes have decreased to nanoscale levels, and

billions of transistors are now included in chips [6]. A vast array of devices, including specialized circuits for diverse purposes like image processing, artificial intelligence, and communication, as well as potent CPUs and GPUs, are included in modern VLSI.

Continuous innovation has defined the development of VLSI technology, enabling us to fit more processing power into smaller places, advancing technology, and changing the world in previously unimaginable ways. The transition from discrete components to highly integrated VLSI circuits had a pivotal role in establishing the current information era. Fig. (**1**) illustrates the evolutionary journey of modern VLSI over the time starting from its birth as a small-scale integrated IC to modern on-chip architectures.

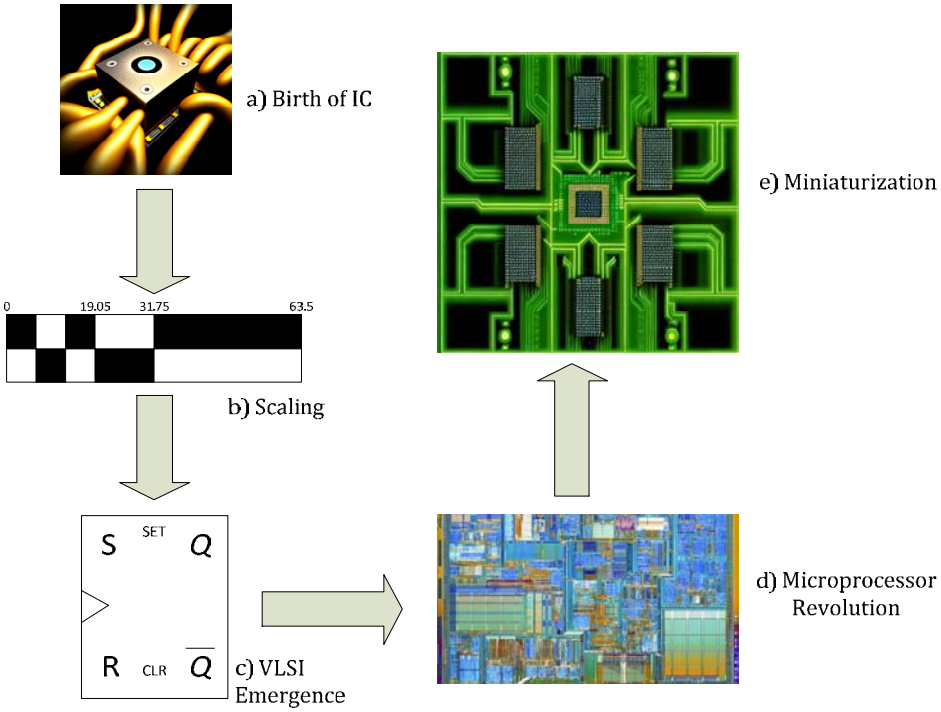

Fig. (1). Evolution of modern VLSI.

3. VLSI ECOSYSTEM: A HOLISTIC VIEW

VLSI technology has developed into a whole ecosystem that integrates hardware, software, and other components, moving beyond the boundaries of individual chips. This change has revolutionized the way we approach the conception,

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