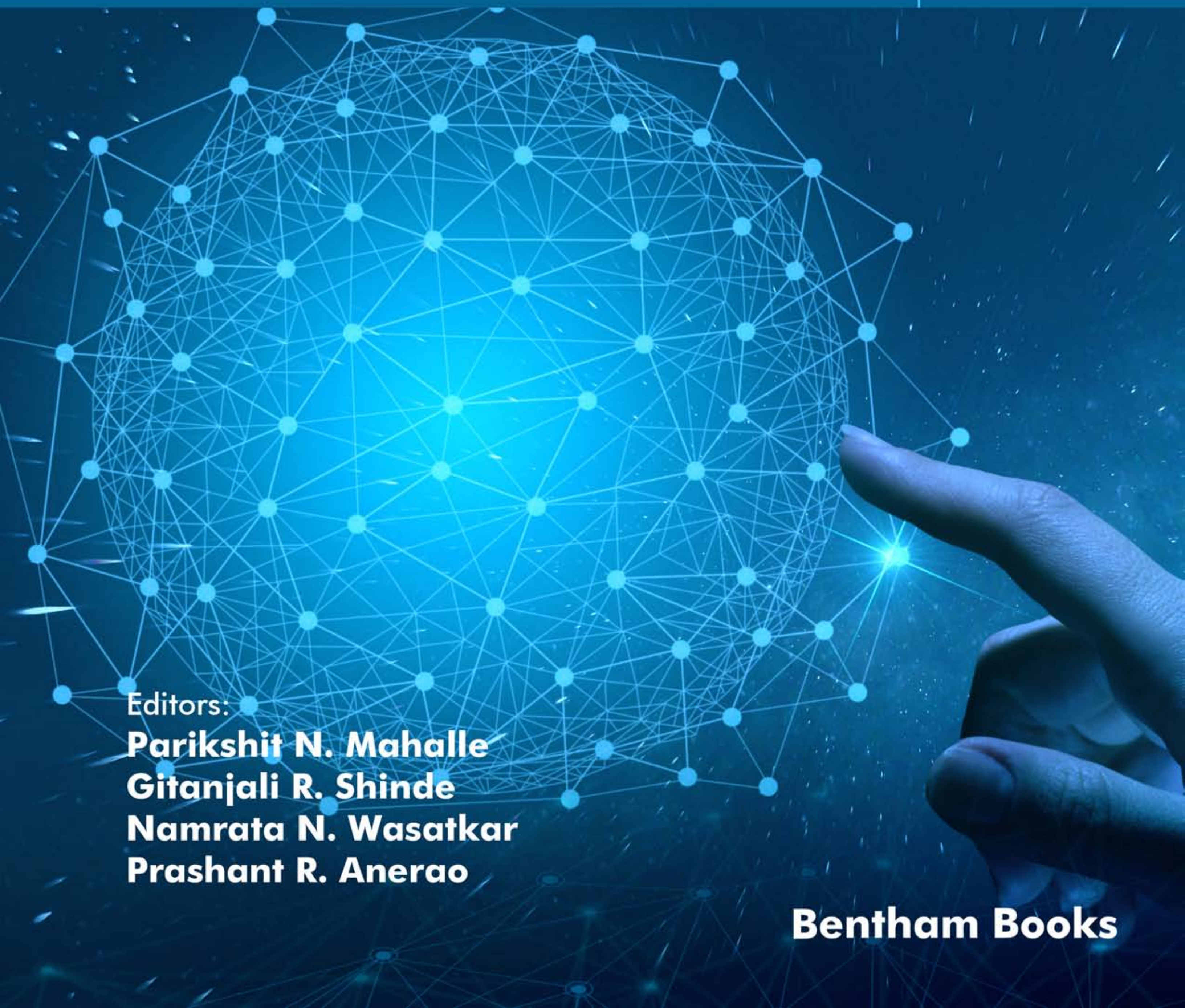
INDUSTRY 5.0 FOR SOCIETY 5.0

ADVANCING MEDICAL IOT AND SMART HEALTHCARE

PART 1



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Bentham Books

Industry 5.0 for Society 5.0: Advancing Medical IoT and Smart Healthcare

(Part 1)

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ISBN (Online): 979-8-89881-045-0

ISBN (Print): 979-8-89881-046-7

ISBN (Paperback): 979-8-89881-047-4

Published by Bentham Science Publishers Pte. Ltd. Singapore,

First published in 2025.

Bentham Science Publishers Pte. Ltd.
No. 9 Raffles Place
Office No. 26-01
Singapore 048619
Singapore
Email: subscriptions@benthamscience.net

BENTHAM SCIENCE

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FOREWORD

I am extremely happy to write the Foreword for an edited book titled “Industry 5.0 for Society 5.0: Advancing Medical IoT and Smart Healthcare” by prestigious Bentham Science Press. This book provides readers an opportunity to explore the transformative potential of Industry 5.0 and its profound impact on society. It is an opportunity to delve into the convergence of advanced technologies and human-centric solutions, shaping a new era of industrial and societal development.

Unlike its predecessor, Industry 4.0, which focused on data digitization and machine automation, Industry 5.0 aims to rebuild a human-centric environment where humans and machines work together to boost work efficiency. This shift towards a more collaborative and cooperative approach between humans and machines is pivotal in fostering a smart manufacturing system.

The book also delves into the vision of Industry 5.0 leading toward Society 5.0, envisioning a smart society equipped with new versions of education and educators 5.0. This evolution aims to lead to a society where humans are equipped with smart collaborative and cooperating robots, emphasizing the transformative potential of these advancements. The book acknowledges that despite Industry 5.0's potential contributions to the world economy, ecology, and society, there will be challenges during its implementation. It also highlights the need for research in prospective areas to address these challenges and maximize the benefits of Industry 5.0 for society. The book includes key areas like medical IoT and healthcare applications.

I would like to congratulate all editors for coming up with valuable contributions on very apt topics and I am sure that this book will be well received by all the stakeholders.

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PREFACE

Industry 5.0 represents a significant evolution in the industrial landscape, focusing on the collaboration between humans and advanced technologies, such as artificial intelligence (AI) and the Internet of Things (IoT). This paradigm shift aims to create a more human-centric approach to industry, enhancing productivity while prioritizing the well-being of individuals and society. Society 5.0, on the other hand, is envisioned as a super-smart society that leverages technology to address social challenges and improve quality of life. It builds upon the foundations of Society 4.0, aiming to create a prosperous, human-centered environment where technology serves to solve pressing societal issues. Society 5.0 envisions a society where advanced IT technologies, the Internet of Things, robots, artificial intelligence, and augmented reality are actively used in everyday life, industry, healthcare, and other spheres for economic advantage and the benefit of citizens. It aims to create a human-centric super smart society with high-quality, comfortable lives.

The relationship between Industry 5.0 and Society 5.0 is described as reciprocal, emphasizing the need to maintain and develop the relationship between industry and society. This reciprocal relationship is crucial for societal development and the integration of advanced technologies to improve welfare. Both Industry 5.0 and Society 5.0 emphasize human-centric approaches, focusing on the integration of technology with the human factor for proper management and achieving the best results. The convergence of Industry 5.0 and Society 5.0 is paving the way for a revolutionary approach to healthcare through the advancement of Medical IoT and smart healthcare solutions. By focusing on human-centric designs and leveraging cutting-edge technologies, the healthcare sector can significantly improve patient outcomes and operational efficiency, ultimately contributing to a healthier society.

This book is a one stop shop that offers the readers everything he/she needs to know or use industry 5.0 for society 5.0. evolution towards industry 5.0 which includes Industry 5.0 for Society 5.0, enabling technologies, opportunities, challenges and future perspectives. The book offers a basic understanding of medical IoT and healthcare applications, and the integration of Medical IoT within the framework of Industry 5.0, patient-centered care, IoT applications and ethical data practices in digital health. Techniques and case studies that include smart computing on the convergence of Industry 5.0 for Society 5.0 for medical IoT and smart healthcare are introduced to the reader. An outlook from where the readers can build upon and work towards developing their applications is presented in the book.

This book provides an overview of various use cases which can be build upon the convergence of Industry 5.0 for Society 5.0 and mainly the role of Industry 5.0 in above mentioned subject areas. A few key features of this books are as follows:

• Discusses the broad background of Industry 5.0, Society 5.0 & its fundamentals.

• The role of Industry 5.0 in medical IoT and healthcare applications and various use cases towards human-centric computing.

• Discusses various technologies, methodologies and approaches that play a prominent role in medical IoT, smart healthcare and Industry 5.0.

• The role of Industry 5.0 for preventive and sustainable healthcare.

In a nutshell, this book displays all information (basic and advanced) that a novice and advanced reader needs to know regarding the role of Industry 5.0 for Society 5.0. The book also motivates the use of appropriate technology for the better development of applications. The book also contributes to social responsibilities by laying down the foundation for the development of applications that can help in making day to day activities easier by meeting the requirements of important sector of healthcare and other vital aspects of human lives.

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CHAPTER 1

Industry 5.0 for Society 5.0 - Enabling Technologies, Opportunities, Challenges and Future Perspectives

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Abstract: The industry 5.0 (I5.0) paradigm shift aims to advance human-centricity, resolving problems, and the ability to make decisions using revolutionary technologies. Technology is a tool that humans may use to enhance their skills and produce greater results, not to replace them. Society 5.0 (S5.0), conversely coined as "Super Smart Society," was conceived by the government of Japan. Human-centered societies strike a balance between economic development and socio-problem resolution by offering products and services. The chapter clarifies how Industry 5.0 and Society 5.0 working together may create a peaceful coexistence that promotes economic progress, innovation, and social well-being. Technological transitions and developments like the Industrial Internet of Things (IIoT), Advanced Robotics, Cobots, Artificial Intelligence (AI), Cybersecurity, and Big data, Cloud computing, enhance the lifestyle of human life and the performance of industries through home automation and industrial automation. The study elaborates on significant areas for technology collaborations to make Industrial 5.0 and Society 5.0 combination to revolutionize various sectors such as inclusive education, health care, power plants, smart cities, sustainable development, and collaborative robots. Industry 5.0 and Society 5.0 show innovation-driven good social development in future generations. The present research adds to the current conversation on the incorporation of new technologies by offering insights into the cooperative development of companies and communities in the direction of a resilient and human-centered future. This chapter also discusses the futuristic perceptions and relevant challenges in attaining Industry 5.0 and Society 5.0.

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Keywords: Artificial intelligence, Industrial internet of things, Industry 5.0, Industrial automation, Smart cities, Society 5.0, Sustainable development.

INTRODUCTION

The fifth industrial revolution is a modern approach to manufacturing that aims to create a system that is more centered around humans, sustainable, and resilient [1]. The I5.0 paradigm emphasizes how crucial it is to give immense importance to this matter of agility and resiliency in systems, and it accomplishes this by using adaptable and flexible technologies. Moreover, the I5.0 approach seeks to promote sustainability by respecting the boundaries of our planet and encouraging diversity, empowerment, and talent. I5.0 has a more comprehensive perspective on the function of the industry, extending beyond just creating jobs and economic growth. The aim is to establish an industry that is both durable and sustainable, and that considers the planet's constraints. Additionally, the well-being of industrial workers is given top priority [2]. The concept of I5.0 addresses the concerns; the emphasis of Industry 4.0 is on the implementation of digitization and AI-powered technological advances have overshadowed the fundamental ideas of fairness and ecological balance. Emphasizing the importance of investigation and industry innovation, I5.0 provides a distinctive approach. It aims to use these tools to deliver long-term benefits to humanity within the limits of our planet [3].

The Japanese government introduced S5.0 in January 2016 - a concept of a futuristic society driven by technological and scientific advancements [4]. The aim of this vision is to create a society that is highly intelligent and human-centered, with a focus on meeting individual needs. The goal of S5.0 is to provide a comfortable and fulfilling life for everyone by merging the physical and cyberspace realms, using Advanced technologies, including 5G, AI, and Big Data, which are currently being utilized [5]. By leveraging these technologies, S5.0 intends to empower individuals with tailored goods and services that cater to their unique needs. To gain a deeper comprehension of the correlation and integration linking I5.0 and S5.0, it is necessary to make a comparison based on their respective definitions. Four dimensions - goal, value, organization, and technology - can be used to compare these two concepts by visualizing their similarities and differences - have been used. The comparison diagram serves to highlight both the differentiation between and resemblance between I5.0 and S5.0, as depicted in Fig. (**1**), providing valuable insights for further exploration and development.

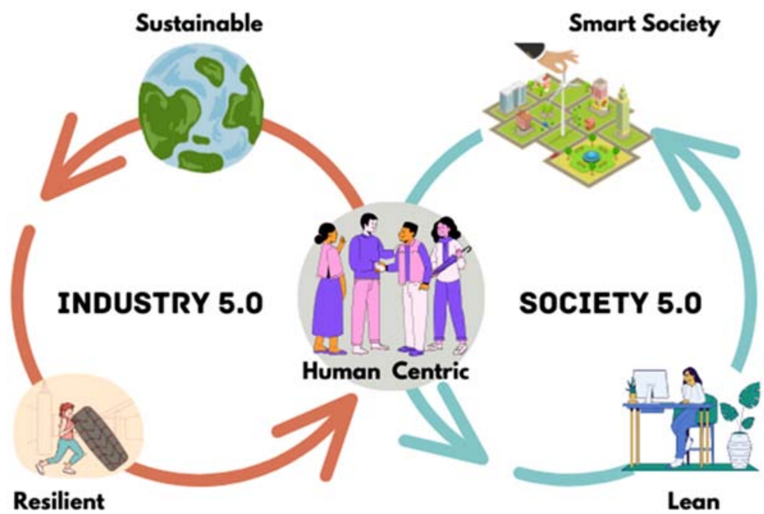

Fig. (1). Comparison of I5.0 & S5.0.

I5.0 and S5.0 are two concepts that prioritize human centricity, which means putting humans at the center of their development and implementation. I5.0 aims to foster human creativity in industries and then promote a shift towards a more human-centered, resilient, and sustainable future. It seeks to address current issues with industrialization and living standards by prioritizing the needs and well-being of people [6]. S5.0, on the other hand, aims to build a lean, human-centered, and superintelligent civilization providing a comfortable additionally good future shared by all. It focuses on developing technology and infrastructure that can enhance the quality of life for people, while also promoting social equity and inclusivity. In the future, individual vitality and demand will play a crucial role in both industry and society, and these concepts will continue to shape life and work.

In I5.0, the product lifecycle has evolved to encompass various aspects such as research and development, production efficiency, tailored services, and recycling. There is a growing trend towards developing value-creation processes at the later stages of the product lifecycle, which is a positive step towards sustainable and responsible manufacturing. S5.0, on the contrary, is expected to be an inclusive and all-encompassing framework that will generate value by means of personalized services, advanced transportation systems, and smart manufacturing systems. This will undoubtedly lead to a more efficient, productive, and environmentally conscious society. The manufacturing cell, factory, and supply chain are the backbone of the industry. I5.0 highlights the need for industrial resilience during COVID-19. S5.0 envisions merging the digital and physical worlds to address social problems. Industry plays a vital role in society's

CHAPTER 2

Industry 5.0 for Society 5.0: Roadmap Ahead

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Abstract: Industry 5.0 is developing suggestive paradigms concerning the future development of societal structures and industrial operations concerning Society 5.0. Industry 5.0 is a complementary digital uprising of Industry 4.0, marked by a profound emphasis on human-machine collaboration, where human expertise and leading-edge technologies—particularly collaborative robots, or cobots —combine to formulate manufacturing systems that are both versatile and configurable to the competencies and creativity of human workers. In this phase, the main visible distinctive features are decentralized decision-making, the extensive use of augmented reality, and a commitment to sustainability.

Society 5.0, on the other hand, aims to create a civilization with a human-centric worldview. It is an association in which the actual world and the virtual space are blended, and data gives visibility between the two. It is about IoT, AI, and big data being put in the service of society to address major societal challenges and ensure they are growing basic lifestyle of people through inclusive and sustainable growth. The paradigm looks at smart cities, personalized healthcare, re-imagined education, and inclusive financial systems as ways technology can be used to address fundamental human needs—for quality of life, environmental stewardship, and equitable access to opportunities.

Keywords: Human-centric AI, Internet of things, Industry 5.0, Society 5.0.

INTRODUCTION

"Industry 5.0" and "Society 5.0" are terms coined to represent stages in the development of industries and societies. These ideas expand on the progress and

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changes seen in societal models [1]. It is an addition to Industry 4.0, which deals with modernized technologies like computer vision, extensive statistical analysis, and machine learning algorithms [1]. Industry 5.0 signifies the new trends in technological development with a human-centric approach to regulate the new revolution in emerging fields. Recognizing essential elements of the human workforce helps characterize the potential benefits of marketing needs. This enhances productivity and employability [1]. Industry 5.0 focuses on economic value towards social development and encompasses innovation with new strategies.

In the evolution of Industry 5.0 and Society 5.0, it becomes evident that finding harmony between technological progress and human principles is crucial. These ideas shape discussions around equitable growth marking a shift towards an era where innovation goes beyond efficiency and advancement to deeply enhancing the human journey [2]. Thus, cognitive learning environments emphasize innovative business and the use of fully integrated services.

INDUSTRY 5.0

In the realm of Industry 5.0, we witness an advancement in practices. This stage expands on the framework established by its forerunners, such as Industry 1.0's focus on mechanization and Industry 4.0's introduction of manufacturing and digital integration. Industry 5.0 is unique in that it places a strong focus on encouraging human-machine cooperation [2]. Fig. (**1**) shown below represents the characteristics of Industry 5.0, which defines the workflow and encompasses the automation, integration, digitalization, customization, and the use of emerging tools.

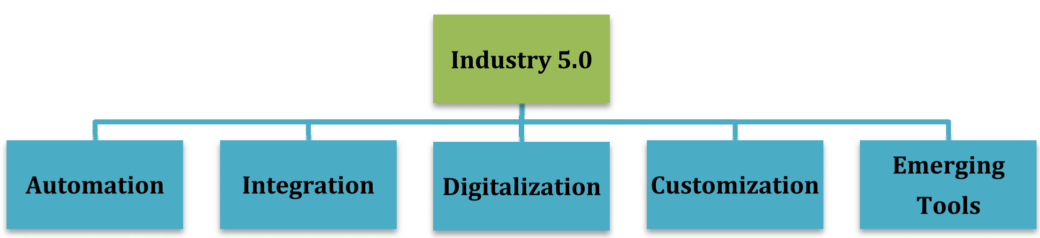

Fig. (1). Industry 5.0.

Industry 5.0 disintegrates the separation of employees from machines advocating for a harmonious blend of human creativity, skills, and intuition, with cutting-edge technologies [3]. Emerging tools like collaborative robots, known as cobots, take center stage in this era by working alongside humans in a beneficial partnership. The ultimate objective is to automate and develop manufacturing processes that not only excel in efficiency and technological sophistication but also prioritize the unique strengths of human laborers [3].

SOCIETY 5.0

"Society 5.0" depicts an outlook for human societies in the future, building on the digital revolutions that started with our agrarian and hunter-gatherer, ancestors and continued through the widespread adoption of digital tech and connectivity in Society 4.0 [4]. Society 5.0 is all about using technology to solve problems and make life better for everyone. It is like a super-duper version of our world, where everything is connected and super smart [4].

Statistical data analytics, computational intelligence, and blockchain technology will all play a big part in this [4]. Imagine a world where your fridge can tell your doctor that you're running low on milk, and your self-driving car can warn the traffic light that it needs a little greener time. It's like living in a giant, awesome, high-tech family that looks out for each other [4]. Fig. (**2**) shown below defines the adaptation of the newest technology to enhance productivity from peer-to-peer interaction and maintain the sustainability of the environment.

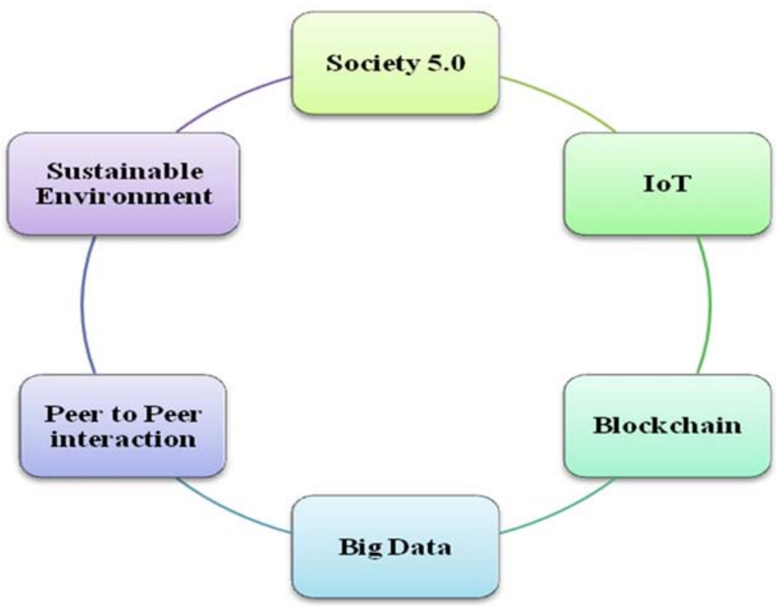

Fig. (2). Society 5.0.

Society 5.0 is used to incorporate appropriate software and hardware requirements with the help of the Internet of Things. Blockchain processes the data modality, and big data contains all information of users and maintains updated records to

CHAPTER 3

Unleashing Opportunities: Bridging Research Gaps in High-Performance Computing for Holistic Decision Support in Clinical Informatics

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Abstract: Objective: This systematic literature review navigates the landscape of high-performance computing (HPC) applications in clinical informatics, focusing on holistic decision support. The study aims to identify and address research gaps, optimize computational algorithms, and explore multi-modal data integration challenges.

Methods: Employing rigorous inclusion criteria, we systematically review existing literature to analyze the current state of HPC in clinical decision support. Methodological details encompass criteria for study selection, the search strategy employed, and the synthesis and analysis of data.

Findings: The review uncovers critical research gaps, notably in the scalability of computational algorithms and the integration of diverse healthcare data types. Optimization techniques and parallel computing approaches emerge as pivotal strategies to bridge these gaps. Challenges in multi-modal data integration and algorithmic approaches for comprehensive data analysis are explored.

Implications: Insights gleaned from real-world applications and case studies contribute to understanding successes and challenges in HPC implementation. Evaluation metrics for performance assessment are synthesized, providing a foundation for future research directions and emerging trends in HPC for clinical informatics.

Conclusion: This systematic review advances our comprehension of the research landscape, offering a roadmap for optimizing HPC applications in clinical decision support. The findings contribute to the ongoing discourse on leveraging computational power for holistic healthcare solutions.

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Keywords: Clinical informatics, Computational algorithms, Decision support, High-performance computing (HPC), Multi-modal data integration, Optimization techniques.

INTRODUCTION

In the ever-evolving landscape of healthcare, the research paper titled "Unleashing Opportunities" takes a pioneering stance at the convergence of High-Performance Computing (HPC) [1] and holistic decision support within clinical informatics. This comprehensive exploration goes beyond computational methodologies to envision proactive strategies that address prevailing research gaps.

Structured meticulously, the paper navigates through foundational aspects of HPC's role in healthcare, proposing strategic optimization approaches [2] while projecting forward to anticipate emerging trends. The term "holistic" anchors the theme, emphasizing comprehensive decision support across diverse healthcare data types like electronic health records, genomic data, and wearable sensor information [3].

More than an academic exercise, "Unleashing Opportunities" is a call to action, inspiring future research endeavors and aiming to catalyze change in clinical decision-making practices. It extends beyond existing understandings, contributing to the evolution of clinical decision support. By engaging with the challenges and promises of HPC in healthcare informatics, this paper seeks to uncover transformative opportunities.

Through a proactive engagement with the challenges and promises of HPC in healthcare informatics, this paper seeks to uncover opportunities that can reshape the very fabric of decision-making in clinical settings.

Background and Context

In the dynamic landscape of healthcare informatics, the convergence of High-Performance Computing (HPC) and holistic decision support represents a pivotal frontier [4]. The escalating complexity and abundance of healthcare data, spanning electronic health records to genomic information, demand advanced computational methodologies [5].

This research unfolds within a healthcare ecosystem grappling with diverse data types and a growing need for sophisticated decision support systems.

The promise of transformative change in clinical decision-making accompanies the advent of HPC [6]. However, challenges and research gaps currently impede its full integration into healthcare [7]. The title, "Unleashing Opportunities," embodies the aspiration to not only identify these gaps but to actively bridge them, unlocking new avenues for comprehensive decision support.

This context is embedded in a field where precision, speed, and nuanced decision-making are paramount [8]. Electronic health records store extensive patient information, medical images provide visual insights, genomic data offers personalized perspectives, and wearable sensors generate real-time health data [9]. Navigating this complex landscape requires computational methodologies beyond conventional capabilities, positioning HPC as a transformative solution [10].

This research emerges at a critical juncture in healthcare, where the fusion of computational power with decision support has the potential to redefine patient outcomes and treatment strategies [3].

"Unleashing Opportunities" is not merely a research endeavor; it is a strategic initiative to propel healthcare informatics into a new era, where the synergy between HPC and decision support becomes a transformative force for improved patient care and outcomes.

Significance of High-Performance Computing in Clinical Informatics

In the evolving landscape of clinical informatics, the integration of High-Performance Computing (HPC) represents a transformative shift, profoundly impacting decision-support paradigms [3]. The research paper titled "Unleashing Opportunities" underscores HPC's profound significance in addressing critical research gaps and advancing comprehensive decision support in clinical informatics.

Swift Data Processing and Analysis: HPC's ability to swiftly process vast volumes of healthcare data is foundational in time-sensitive clinical settings [10]. Rapid processing and analysis enable more responsive interventions and timely decision-making.

Precision and Accuracy in Decision-Making: Precision is paramount in clinical decisions [11], and HPC ensures highly accurate analyses, reducing the margin for error [8]. This computational precision enhances the reliability of insights derived from healthcare data.

Handling Complex and Diverse Data Types: Clinical informatics involves managing diverse data types, and HPC's capability to handle complex datasets,

CHAPTER 4

Integration of Internet of Medical Things (IoMT) and Artificial Intelligence Applications in Healthcare and Medicine – A Multi-Disciplinary Perspective

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Abstract: Advanced information technologies drive innovation, with the Internet of Things (IoT) impacting medicine and healthcare sectors. The delivery of patient care and medical procedures has been transformed by the adoption of IoT technologies. It assists in medical records management, aids in understanding disease causes, and early detection of the disease, which in turn give people the confidence to take charge of their well-being. The utilization of wearable health trackers, implantable sensors, and smart medical devices facilitated by IoT has significantly eased real-time monitoring, diagnosis, and treatment optimization, marking a revolutionary shift toward preventive healthcare. Virtual telemedicine technologies like video conferencing and remote health monitoring systems reduce in-person doctor appointments. Telemedicine lowers treatment expenses and saves time for patients and medical professionals alike. Telemedicine devices with remote patient monitoring hardware provide great video quality for real-time predictive healthcare systems. Medical surgical robots execute precise surgical tasks with exceptional accuracy and control. Robotic Surgical System facilitates surgeons to precisely control the surgeries through magnified 3D vision, and wrist-mounted controls, enabling precise incisions.

Minimally Invasive Neurosurgical Intracranial Robot with cutting-edge robotic systems using Shape memory alloy actuators are utilized for brain tumor removal. A cyber-physical system (CPS) is introduced which includes continuous monitoring of vital health parameters (*e.g.*, blood glucose, blood pressure) and triggers automated treatment when critical levels are detected, easing patient care. Al diagnostic tools, using image recognition and natural language processing, improve medical decisions and patient outcomes. This chapter discusses the Internet of Medical Things, Surgical

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Robots, Medical Robot Actuation and Control of Sensors and Actuators, Cyber-Physical Health Systems, and Artificial Intelligence applications in healthcare sectors like disease identification and its remedial preventive actions, sensorial fusion techniques in healthcare sectors.

Keywords: Cyber-physical health systems, Healthcare automation, IoMT, Preventive healthcare, Surgical medical robots, Telemedicine.

INTRODUCTION

In a time of exponential technological development, the healthcare industry is at the forefront of change. The combination of the Internet of Medical Things (IoMT), telemedicine, and healthcare automation has ushered in a new era in healthcare delivery and management. At the same time, cyber-physical health systems, medical-surgical robots, and preventive health interventions have become key elements of a paradigm shift towards more efficient, accessible, and patient-centered care. This chapter describes the combination of these disruptive technologies and provides a comprehensive overview of their overall impact on the healthcare industry. From leveraging IoMT for remote patient monitoring to seamless delivery of healthcare services *via* telemedicine platforms, every innovation plays a key role in improving the accessibility and efficiency of healthcare. Additionally, implementing automation in healthcare simplifies administrative tasks and allows healthcare professionals to allocate more resources to provide patient-centered care. This chapter details how cyber-physical healthcare systems and medical-surgical robots are transforming surgical techniques, diagnostics, and treatments. Additionally, the emerging topic of health care is explored and the importance of a proactive approach to preventing disease and promoting well-being is highlighted. This chapter provides a detailed overview of the disruptive innovations transforming the healthcare landscape through in-depth analysis and illustrative case studies. This is a valuable resource for healthcare providers, researchers, policymakers, and technologists, providing insights into how these innovations can be used to improve patient outcomes and reshape the future of healthcare.

EVOLUTION OF IOMT FROM IOT

The development of the Internet of Medical Things (IoMT) from the Internet of Things (IoT) signifies a major advancement in applying connected technology within the healthcare sector. Initially, IoT involved a network of physical objects with embedded sensors, software, and other technologies to gather and exchange data over the Internet. These technologies were first applied in diverse fields such as smart homes, industrial automation, and smart cities, focusing on improving efficiency, automation, and data-driven decision-making [1]. In healthcare, early

IoT applications included wearable devices like fitness trackers and smartwatches that monitored physical activity, heart rate, and sleep patterns. These devices provided essential health data to users and healthcare providers, promoting a proactive approach to health management. Additionally, remote monitoring tools were developed to track vital signs like blood pressure, glucose levels, and oxygen saturation. These tools allowed for continuous monitoring of patients with chronic conditions, minimizing the need for frequent hospital visits and enabling more timely medical interventions [2].

Building on these initial technologies, IoMT emerged as a specialized branch of IoT focused solely on healthcare applications. This transition led to the creation of advanced connected medical devices and applications, including sophisticated wearable health monitors, implantable devices, smart pills, and telemedicine platforms. For example, advanced wearable health monitors can track a variety of health metrics in real-time, such as electrocardiograms (ECG) and blood oxygen levels, allowing for continuous health monitoring and early detection of potential issues. Implantable devices, like pacemakers and insulin pumps, provide critical data and adjust their functions based on real-time monitoring, thereby improving patient outcomes. Smart pills, equipped with ingestible sensors, can track medication adherence and provide data on how drugs interact within the body, enhancing treatment effectiveness. Telemedicine platforms have also become an essential component of IoMT, enabling patients to consult with healthcare providers remotely, thus increasing access to medical care, especially in underserved areas [3].

IoMT not only enhances real-time health monitoring and personalized treatment plans but also significantly improves data management and the accuracy of medical records. This interconnected network of devices facilitates seamless communication among healthcare providers, leading to more coordinated and efficient care delivery. Moreover, IoMT leverages advancements in big data analytics and artificial intelligence (AI) to derive valuable insights from the vast amounts of data generated by connected devices [4]. These technologies support predictive analytics, which can anticipate disease outbreaks, improve the management of chronic illnesses, and optimize resource allocation in healthcare settings.

The integration of AI with IoMT enables advanced data analysis, identifying patterns and trends that may not be immediately evident to human analysts. For example, AI algorithms can predict patient deterioration based on subtle changes in vital signs, prompting early interventions that can prevent complications and hospitalizations. Additionally, AI-powered decision support systems can assist healthcare providers in diagnosing conditions and recommending treatment plans,

CHAPTER 5

Decoding Diabetic Retinopathy Images: A Comparative Analysis of Deep Learning Models for Effective Severity Grading

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Abstract: Diabetic retinopathy (DR) is a leading cause of vision loss, making early detection and accurate severity assessment crucial for timely intervention. This study evaluated five pre-trained deep-learning models for classifying DR severity levels from fundus images. Encompassing diverse architectures like ResNet50 and EfficientNetB5, the models were extensively trained and validated for generalizability. Performance was assessed using ordinal regression metrics (MAE, MSE, QWK), ROC-AUC, specificity, sensitivity, and visualizations like confusion matrices and model architectures.

DenseNet121 and EfficientNetB5 emerged as top performers, with DenseNet121 excelling in precise severity predictions due to its outstanding MAE, MSE, and QWK scores. Confusion matrices provided insights into misclassifications, while ROC-AUC analysis confirmed the models' strong discriminative ability. DenseNet121 and EfficientNetB5 hold significant promise for aiding early DR detection and accurate severity assessment, potentially paving the way for timely intervention and personalized patient care. Future research should focus on fine-tuning strategies and external validation to enhance model generalizability and real-world clinical utility.

Keywords: Diabetic Retinopathy (DR), Deep Learning (DL), DenseNet121, EfficientNetB5, Early detection, Personalized care, Severity classification.

INTRODUCTION

Diabetic retinopathy (DR), a microvascular complication arising from diabetes mellitus, remains a significant global public health concern, consistently ranked as a leading cause of vision loss. Early and accurate diagnosis plays a pivotal role in enabling timely intervention and preventing irreversible vision impairment. Recent advancements in deep learning (DL) techniques, particularly those

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leveraging deep neural networks (DNNs), have reshaped the landscape of medical image analysis, offering immense promise for automated DR detection.

This chapter embarks on a comprehensive review of the relevant literature, specifically focusing on methodologies that employ DNNs, particularly convolutional neural networks (CNNs) and image-based DL approaches, for automated DR diagnosis. The exploration begins by examining the groundbreaking work [1] introducing Densely Connected Convolutional Networks (DenseNets). This novel architecture demonstrably enhanced information flow within neural networks, improving learning capabilities. Their work catalyzed subsequent research endeavors [2 - 4] that explored the potential of CNNs in achieving heightened accuracy and sensitivity in DR diagnosis. Recognizing the need for further optimization, researchers have actively pursued advancements in existing DL architectures specifically tailored for DR detection. A study proposed a feature-based optimized deep residual network architecture, improving model performance [5]. The introduction of the EfficientNet model [6] further revolutionized CNN scaling, achieving superior performance while maintaining computational efficiency. These advancements significantly contribute to the potential for practical DL application in real-world clinical settings.

This chapter extends beyond a mere examination of CNN architectures. Valuable insights from a broader spectrum of research [7 - 10] are incorporated. These studies delve into critical aspects that are essential for the field's continued progress, encompassing:

- Seamless integration of DL into robust and automated DR detection systems, facilitating broader clinical adoption.
- Development of reliable algorithms ensuring accurate and generalizable diagnosis across diverse patient populations.
- Comprehensive surveys that map the DL landscape for DR classification, foster a more holistic understanding of the field and its potential applications.

However, a discernible research gap emerges in the exploration of deep image mining techniques for efficient and comprehensive DR screening. The pioneering study introduces this concept, hinting at its potential to enhance sensitivity and specificity in DR screening [11]. Further investigations and developments are warranted to harness the potential of deep image mining approaches, potentially pushing the boundaries of what is achievable in automated diabetic retinopathy diagnosis.

This chapter delves into the world of deep learning (DL) for diabetic retinopathy (DR) detection. By drawing on insights from various studies, it dissects current methods, pinpoints emerging trends, and proposes exciting directions for future exploration. Ultimately, this chapter aims to significantly contribute to the development of accurate, efficient, and accessible tools for early DR detection. The goal is to significantly contribute to the development of accurate, efficient, and accessible tools for early DR detection. This, in turn, has the potential to improve patient outcomes and substantially reduce the global burden of vision loss associated with DR. While the current study explored ResNet, DenseNet, and EfficientNet architectures, further investigation is necessary to identify the optimal choice for real-world clinical settings. External validation with diverse datasets, fine-tuning hyperparameters specifically for DR tasks, and exploring multi-class classification alongside ordinal regression are all crucial for achieving robust and generalizable DR diagnosis. These future directions will solidify the most appropriate deep-learning architecture for accurate DR detection.

RELATED WORK

Diabetic retinopathy (DR) remains a significant global public health concern. Early detection through effective screening programs is critical for preventing vision loss. Deep learning has emerged as a powerful tool for automated DR analysis, offering promising avenues for both detection and severity grading. This section reviews relevant research on deep learning for DR image analysis, focusing specifically on approaches for severity grading. Diabetic retinopathy (DR) detection using deep learning (DL) has burgeoned into a dynamic and rapidly evolving field, marked by impactful research endeavors. This section conducts a critical examination and categorization of the existing literature, providing valuable insights into the development and application of DL techniques for DR classification.

Atwany, Sahyoun, and Yaqub (2022) present a comprehensive survey that serves as a cornerstone reference for the field. Their meticulous work maps the landscape of available DL methodologies for DR classification, establishing a robust foundation for further research endeavors [12]. This foundational survey provides a systematic overview, guiding subsequent research in understanding the intricacies of DL techniques for diabetic retinopathy detection. Kermany, Goldbaum, Cai, Valentim, Liang, Baxter, *et al.* (2018) laid the groundwork for image-based DL in medical diagnoses, showcasing its remarkable potential for identifying treatable diseases, including diabetic retinopathy. While extending beyond DR, their work emphasizes the broader impact of DL across healthcare applications, paving the way for its integration into various medical domains [13]. This pioneering research underscores the transformative potential of image-based DL not only for diabetic retinopathy but also for a wide range of medical conditions, driving advancements in healthcare technology.

CHAPTER 6

Smart Diagnostic: Machine Learning for Early Detection and Prediction of Heart Disease

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Abstract: Coronary Heart Disease (CHD) stands as a significant global health concern, contributing substantially to mortality rates across the world. The complexity of CHD data, with its intricate interconnections, has posed a challenge for traditional predictive methods. The integration of intelligent models using machine learning techniques is pivotal in advancing our understanding and predictive capabilities in the realm of CHD. The three chosen methodologies, Naïve Bayes (NB), Support Vector Machine (SVM), and Decision Tree (DT), each bring unique strengths to the analysis of the complex CHD dataset. The goal of the study is to use 10-fold cross-validation in conjunction with careful creation and validation procedures to fully utilize the potential of these models in order to find important but subtle correlations in the data. This approach holds promise for improving prediction rates, offering a potential breakthrough in the realm of cardiovascular health. As machine learning continues to evolve, the application of these techniques to CHD data not only contributes to predictive accuracy but also opens avenues for more targeted interventions and personalized healthcare strategies in the ongoing battle against coronary heart disease.

Keywords: Artificial Neural Network (ANN), Artificial Neural Network (ANN), Classification and Regression Tree (CART), Convolutional neural networks (CNN), Chronic heart failure (CHF), Coronary Heart Disease (CHD), Deep learning (DL), Decision Tree (DT), Decision Tree (DT), Deep neural networks (DNN), Hybrid random forest with a linear model (HRFLM), Logistic Regression (LR), Machine learning (ML), ML-based heart disease diagnosis (MLBHDD, Naïve Bayes (NB), Random Forest Classifier (RFC), Support Vector Machine (SVM).

INTRODUCTION

Cardiovascular diseases (CVD) stand as major global causes of mortality, with more than 17.9 million deaths annually, primarily attributed to heart attacks and

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strokes. Unhealthy lifestyle factors contribute to CVD, emphasizing the need for early identification and treatment to prevent premature deaths. Access to cheap cardiovascular diagnosis is a challenge for low- and middle-income countries, especially Bangladesh, India, and several African countries. Electrocardiogram (ECG) diagnosis, while effective, is time-consuming. The introduction of ML to medical applications—more especially, MLBHDD systems—offers adaptable and affordable solutions. Various studies, such as those by Bashir *et al.* (2016) and Daraei and Hamidi (2017), have utilized ML algorithms to predict and analyze heart diseases, achieving notable accuracy. DL, including CNN and DNN, has further enhanced accuracy. However, challenges persist, including the limited interpretability of ML and DL models and potential biases in imbalanced datasets. This necessitates a systematic literature review (SLR) to analyze recent trends, techniques, and gaps in ML-based heart disease diagnosis, providing valuable insights for future research.

The global health concern of CVD accounts for 31% of deaths worldwide. It underscores the significance of accurate prediction using ML techniques, proposing methods like LR and random forest for heart disease diagnosis. The focus extends to CHF, highlighting the urgency of early detection and proposing an enhanced ML and DL approach for distinguishing between healthy and decompensated CHF individuals. The study also addresses the silent nature of heart diseases and the crucial role of ML in managing cardiovascular diseases by categorizing patient data for improved prognostic accuracy. Additionally, it introduces an ML algorithm for heart disease prediction and an Internet of Things (IoT)- based patient monitoring system, illustrating the potential of ML and IoT in advancing cardiovascular health management.

LITERATURE SURVEY

Researchers are now adopting data-driven methods for diagnosing early-stage cardiac illness with the help of ECG signals thanks to the development of ML. ML methods address delayed diagnosis issues, enabling self-diagnosis through the routine use of low-cost sensors. Yang *et al.* (2018) found that a CNN-based method produced 98.41% accuracy in arrhythmia detection, while a linear support vector machine produced 97.77% accuracy. The MIT-BIH arrhythmia heart disease open repository dataset was used in both techniques. Similar to this, Che *et al.* (2021) used real-world data to apply a CNN-based method for extracting temporal information from ECG signals. Together, these studies demonstrate how revolutionary machine learning can be in the early identification of heart-related disorders [1].

A data mining model was created utilizing 100 CHD records that included survival rate information in order to meet the medical society's demand for CHD prediction. Using 502 examples, SVM, ANN, and DT were used, with corresponding accuracy rates of 92.1%, 91.0%, and 89.6%. SVM emerged as a robust classifier. In addition, association rule mining was investigated in order to find important patterns in a dataset consisting of 14 attributes. Different classifier models using DT, NB, and ANN were built, and results, presented through receiver operating characteristic (ROC) curves, revealed ANN's superiority with an area above 80%, outperforming Naïve Bayes and DT algorithms [2].

Recent studies, exemplified by Gjoreski *et al*., showcase a paradigm shift in chronic heart failure (CHF) detection, leveraging ML and DL. Their approach, integrating classic ML with expert features and end-to-end DL, demonstrates superior performance over baselines. This reflects a broader trend in cardiovascular research, emphasizing data-driven solutions for CHF diagnosis. The study's focus on expert features adds nuance to personalized healthcare in automated heart sound analysis. Overall, this synthesis of ML and DL marks a significant step toward effective, scalable, and patient-centric CHF detection [3].

Cardiopulmonary exercise testing (CPX) has become pivotal in prognosticating chronic heart failure (HF) outcomes. The study by Corra *et al*. underscores CPX's significance by integrating cardiac, skeletal, and pulmonary factors from a holistic perspective, surpassing traditional indicators. Peak oxygen consumption stands out as a key metric, reflecting its prognostic value. The inclusion of exercise-related ventilatory abnormalities adds innovation to HF prognostication. This literature signifies a paradigm shift, providing a concise yet comprehensive overview of CPX's role in individualized treatment outlines for HF patients [4].

Recent studies by Valle Harsha Vardhan *et al.* explore machine learning applications in heart disease prediction, employing algorithms like hill climbing, decision trees, and Naïve Bayes. Avinash Golande *et al.* emphasize the utilization of diverse techniques, including K-nearest neighbor and decision trees, to enhance diagnostic accuracy. Additionally, the integration of DL, as seen in the work by Abhay Kishore *et al*. using recurrent neural systems, points to a promising direction in forecasting heart-related conditions. Together, these initiatives show how machine learning has the power to transform the diagnosis of heart disease and enhance patient outcomes [5].

This research tackles the vital task of predicting cardiovascular disease, a major global health concern. Utilizing ML and acknowledging its relevance in clinical data analysis and IoT, the study introduces an innovative approach. The method aims to enhance prediction accuracy by identifying significant features through

CHAPTER 7

IoT Applications in Digital Health Care

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Abstract: Over and past decade, significant advancements have been made in healthcare services, driven by continuous research and technological innovation. The Internet of Things (IoT), in particular, has demonstrated immense potential by connecting medical devices, sensors, and healthcare professionals to deliver high-quality care even in remote and isolated areas. This technology has enhanced patient safety, enabled at-home care, reduced healthcare costs, improved service accessibility, and increased operational efficiency within the healthcare industry. IoT has transformed the traditional hospital-centered healthcare system into a patient-centered model. Various clinical analyses, such as monitoring blood pressure, blood glucose levels, and oxygen saturation (pO_2), can now be performed at home without requiring assistance from healthcare professionals. Additionally, clinical data collected remotely can be transmitted to healthcare centers using advanced telecommunication technologies. The integration of these communication services with IoT has significantly improved access to healthcare facilities.

This study provides a comprehensive overview of the latest IoT-based healthcare applications, focusing on enabling technologies, healthcare services, and solutions to address various healthcare challenges. Furthermore, it serves as a valuable resource for future researchers interested in contributing to the advancement of IoT technologies in patient care, offering insights into the diverse applications and benefits of IoT in the healthcare sector.

Keywords: Clinical analysis, Centric healthcare, Healthcare services, Healthcare professionals, Internet of Things (IoT), Patient care.

INTRODUCTION

The fusion of healthcare and cutting-edge technology has given rise to a transformative revolution in the way we perceive and practice medicine. In this era of unprecedented innovation, the Internet of Things (IoT) has emerged as a pivotal force in reshaping healthcare as we know it. The amalgamation of IoT and

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healthcare often referred to as "IoT in Healthcare" or "Healthcare IoT," is not merely a technological leap; it represents a profound shift towards more personalized, efficient, and accessible healthcare solutions.

IoT, at its core, involves the interconnection of everyday objects and devices to the internet, enabling them to collect, exchange, and analyze data autonomously. In the realm of healthcare, this concept transcends conventional boundaries, creating a networked ecosystem where medical devices, wearables, sensors, and patient data converge to empower both healthcare providers and patients alike. The architecture of IoT-based health care system is given in Fig. (**1**).

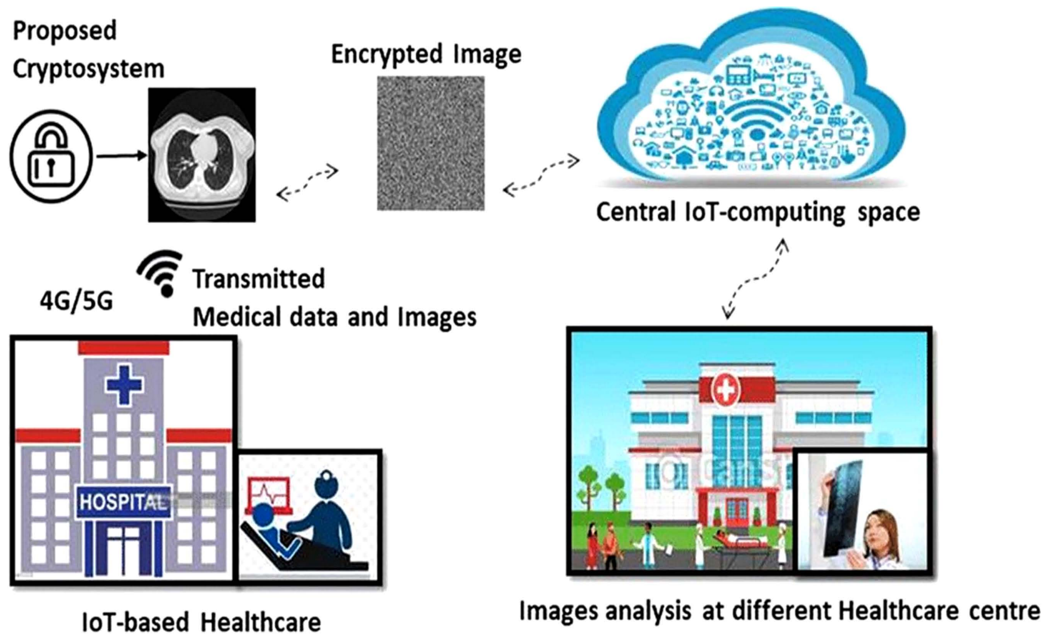

Fig. (1). The architecture of IoT-based health care system [1].

This article embarks on a journey through the intricate landscape of IoT applications in healthcare, exploring the multifaceted ways in which this technology is reshaping the healthcare landscape. We will delve into the innovative solutions that IoT offers, from remote patient monitoring and smart medical devices to predictive analytics and telemedicine. Moreover, we will examine the broader implications of these advancements, including improved patient outcomes, cost reduction, and the democratization of healthcare.

As we navigate this captivating intersection of technology and healthcare, it becomes apparent that IoT applications have the potential to not only enhance the quality of care but also usher in a new era of healthcare delivery, one that is more patient-centric, data-driven, and interconnected than ever before. In doing so, IoT in healthcare is not merely a technological advancement but a profound catalyst for the betterment of human health, promising a future where healthcare is not just reactive but predictive and preventive, where patient well-being is constantly monitored, and where healthcare services are tailored to individual needs. Welcome to the world of IoT applications in healthcare, where the future of medicine is taking shape before our eyes.

Over the past decade, significant research and technological advancements have been made in healthcare services. The Internet of Things (IoT) has demonstrated promising applications by connecting various medical devices, sensors, and healthcare professionals to deliver high-quality medical care in remote and inaccessible areas. IoT has contributed to enhancing patient safety, reducing healthcare costs, improving access to healthcare services, and increasing operational efficiency within the healthcare industry.

This study provides a precise overview of the potential applications of IoT-based technologies in healthcare. It highlights the advancements in Healthcare IoT (HIoT) from the perspectives of enabling technologies, healthcare services, and applications aimed at addressing various healthcare challenges.

Technology has transformed healthcare from a hospital-centric system to a patient-centric model [2, 3]. For instance, various clinical tests, such as monitoring blood pressure, blood glucose levels, and pO_2 levels, can now be conducted at home without requiring assistance from healthcare professionals. Clinical data gathered in remote areas can be transmitted to healthcare centers using advanced telecommunication services.

The integration of these services with rapidly evolving technologies, including machine learning, big data analytics, IoT, wireless sensing, mobile computing, and cloud computing, has significantly improved access to healthcare facilities. IoT, in particular, has broadened human interaction with the external environment by utilizing advanced protocols and algorithms. It connects numerous devices, wireless sensors, home appliances, and electronic systems to the Internet [1].

The growing popularity of IoT is attributed to its benefits, such as increased accuracy, reduced costs, and enhanced ability to predict future events. The rapid adoption of IoT has been fueled by advancements in software and applications, the widespread availability of wireless technologies, and the expanding digital economy, leading to an accelerated IoT revolution [4].

Healthcare applications utilize various sensors to collect physiological data from patients, such as temperature, heart rate, electrocardiograph (ECG), and

CHAPTER 8

Cyber Security in Healthcare

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Abstract: Cyber security in healthcare focuses on safeguarding electronic information and assets against unauthorized access, use, or disclosure. The healthcare sector faces significant cyber security risks, with patient care and safety hanging in the balance. Its size, reliance on technology, sensitive data, and susceptibility to disruptions make healthcare facilities appealing targets for cybercriminals. In recent years, cyber-attacks have surged across various sectors, such as healthcare, finance, and manufacturing. In particular, the healthcare industry has become a top target due to insufficient security measures, outdated practices, and valuable sensitive data such as usernames, passwords, and medical records.

Keywords: Cyber-attack, Cybercriminals, Health care, Medical records, Security, Security risks.

INTRODUCTION

Cyber-attacks are increasingly targeting the healthcare industry, making it a primary focus for attackers. Future studies will concentrate on the application of cyber security within the healthcare sector, particularly exploring the various techniques used to defend Internet of Things (IoT)-based healthcare systems [1]. The study also examines various types of security threats within the healthcare industry. Cyber security is a rapidly evolving field of research with diverse applications across multiple sectors, including government services, military, healthcare, education, and manufacturing [2]. Financial services and transportation are also sectors impacted by cyber security risks. Previously, financial services were considered the most at-risk, but by 2015, the healthcare sector became the leading target for cyber-attacks [3].

Many cyber security applications are based on the Internet of Things (IoT), where IoT applications present unique challenges in terms of data transmission methods,

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posing various cyber security difficulties. The Internet of Things (IoT) connects cyberspace with the physical world. In IoT-based healthcare applications, multiple sources are used to collect patient data, which is then compiled into Electronic Health Records (EHR). These records can be either transferred over the internet or uploaded to the cloud. The Electronic Health Record (EHR) is a structured way to collect all electronic health information related to patients [4]. Additionally, these digital records can be shared across various healthcare settings [5]. These include various types of data such as demographics, medication history, medical conditions, and laboratory test results. Additionally, it contains the patient's billing information [6]. Healthcare applications are very critical and need to be powerfully protected.

Cyber security has not received sufficient attention in the healthcare sector, despite its critical importance for patient safety and hospital reputation. To prevent data breaches that could compromise patient privacy, hospitals must implement effective IT security measures. This research article reviews several professional publications addressing ransomware attacks and other cyber-attacks on hospitals from 2014 to 2020. The report highlights the latest defence strategies presented in the scientific literature that can be applied within the healthcare industry. Additionally, it provides an overview of the impacts of cyber-attacks and the steps hospitals have taken to manage and recover from these incidents [7, 8]. The study emphasizes that cyber-attacks on hospitals have serious consequences and underscores the need for prioritizing cyber security in healthcare. To counter cyber-attacks, hospitals must establish clear policies and backup plans, regularly update their systems, and train staff to identify and handle online threats. The paper concludes that implementing robust cyber security measures can mitigate the damage caused by system failures, reputational harm, and other related issues [9].

The intelligent Internet of Things (IoT), which provides an endless amount of networking possibilities for exploring medical data, is improving the connection between technology and healthcare society [10]. Deep networks have seen productive changes in recent years, and the use of medical wearables has become more widespread. The Internet of Things enabled by deep neural networks has led to innovative social breakthroughs in medicine and opened new avenues for health data research [11]. So these kinds of applications do not use old-style safety appliances. However, not all the mechanisms are entirely newly produced. Some traditional mechanisms are used with slight modifications in it. Thus the healthcare industries have to be muscularly secured and protected from any kind of attacks and cyber-criminals. This chapter aims to assess the most common threats that face the healthcare industries and their countermeasures [12].

Despite the progress that has been made, there are still several issues that need to be addressed in terms of quality of service. Gray Filter Bayesian Convolutional Neural Network or GFB-CNN is a smart healthcare method that is powered by Deep Neural Networks and uses real-time data [13]. This technique is presented here as part of this study.

The health zone can have a lot of security concerns, especially with the Internet, where cyber-attacks are becoming more common and sophisticated. Rights of entry and control breaches, attacks that breach and run malware, and DoS (denial of carrier) attacks are some of the maximum common threats to healthcare protection [14]. When evaluating paid Denial of carrier (DDoS) attacks that lease multiple hosts to attack a machine, DoS attacks involve a free pool that floods the target machine with requests. This makes it difficult to determine the origin of the attack. Patients may also suffer as a result of these attacks, and healthcare agencies may additionally suffer from reputational damage [15]. The next most important threat to the healthcare sector is malware, which comes in new forms all the time. Ransomware is one family of malware that healthcare facilities are becoming interested in. Ransomware was ranked 2^{nd} on the list of cyber security risks for healthcare businesses in a survey with the help of the Healthcare Statistics and Management Structure Society (HIMSS), with 17% of respondents saying they had been the victim of a ransomware attack [16]. Healthcare businesses have been the target of several high-profile cyber-attacks in recent years, for example, the 2021 ransomware attack that hit the Irish government fitness carrier (HSE) severely disrupted healthcare services [17]. Similarly, more than 150 countries were affected by the Wanna-Cry ransomware attack in 2017, which prompted the UK's National Fitness Provider (NHS) to reschedule tactics and cancel appointments. Healthcare facilities should put robust cyber safeguards in place to stop cyber-attacks and protect sensitive patient information [18].

However, many healthcare facilities lack adequate security protocols, leaving them open to intrusions. The simplest 44% of healthcare agencies, in line with the view through the Ponemon Institute, have intensive protection around based on responses from 167 healthcare cyber security specialists. The author's approach concerned conducting a content evaluation of clinical papers from 2014 to 2020 that mentioned malware, DoS, and social engineering attacks on hospitals [19]. There are five sections in the document. Hospitals that have carried out qualified cyber-attacks between 2014 and 2020 are classified as Phase II. Hospitals can practice the measures discussed in Phase III to mitigate or prevent a cyber-attack. Effects and discussions are presented in Part IV, and the paper is wrapped up in Phase V.

CHAPTER 9

An IoT-enabled Women's Security Device Utilizing Arduino for GPS Tracking and Alerts in the Context of Industry 5.0

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Abstract: India is becoming a superpower in today's fast-paced world thanks to its technological advancements and other areas. However, there has not been a significant decline in the crime rate against women and children. For this reason, to lower the number of crimes against women and children, greater awareness and technological assistance are required. Our proposal is for a “Safety Device using IoT” that tracks the victim's whereabouts continually using a GPS tracking system, calls phone numbers registered with the system, and sends out continuous SMS messages with the victim's location. We are attempting to address the current need for widely available, affordably accessible technology with this system that we are developing. The abstract presents a women's security device that enhances women's security through GPS tracking and alerts. The Arduino microcontroller platform serves as the system's main building block and allows for the integration of several sensors and communication tools. Women may always have it with them because the device is designed to be easily carried and portable. GPS tracking technology allows for real-time position monitoring, which can expedite emergency response times. The alert system uses a combination of vibration and sound to warn the user and anybody nearby in the event of danger.

Keywords: Current, Electronic appliances, Real-time monitoring, Health, Voltage.

INTRODUCTION

In the contemporary landscape, ensuring personal safety, especially for women, has become a paramount concern. The apprehension associated with traveling alone, particularly at night, underscores the need for innovative solutions that leverage technology to mitigate risks and provide a sense of security. Women, who are often perceived as more vulnerable to various forms of violence, inclu-

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ding robbery, sexual assault, rape, and domestic violence, can benefit significantly from advancements in personal safety devices. The prevailing societal challenges have prompted a reevaluation of safety measures, acknowledging the need for proactive strategies to reduce the likelihood of individuals, particularly women, becoming victims of violent crimes. Recognizing and responding to unsafe situations is crucial, and this has spurred the development of technology-driven solutions aimed at empowering individuals to enhance their personal safety. One notable technological intervention in this domain is the integration of GPS tracking and alerts in personal safety devices. This advancement serves as a beacon of hope, offering women a tool to bolster their confidence when traversing unfamiliar or potentially risky environments, such as walking alone or commuting. The convergence of technology, in this case, revolves around the implementation of the Arduino platform, a versatile microcontroller system renowned for its adaptability to integrate various sensors and communication technologies. The women's safety device utilizing GPS tracking and alerts, based on the Arduino platform, epitomizes the fusion of hardware and software to create a portable, user-friendly solution. Arduino's programmable nature enables the incorporation of diverse sensors, including GPS modules, accelerometers, and communication interfaces, to craft a comprehensive safety apparatus. The GPS tracking feature allows individuals, and specifically women in this context, to share their real-time location with trusted contacts or emergency services. This functionality proves invaluable in situations where immediate assistance is required. Additionally, the device can be programmed to send alerts or distress signals if predefined parameters indicative of potential danger are met. The portable nature of this safety device ensures ease of use, enabling women to carry it effortlessly during their daily activities. Its discreet design contributes to user comfort, fostering a sense of empowerment rather than intrusion. Moreover, the integration of Arduino facilitates customization, allowing for the adaptation of the device to cater to specific user preferences and requirements. The impact of such technological innovations extends beyond the individual level. By providing women with tools that enhance their safety and security, society takes a collective step toward creating an environment where everyone feels protected. The synergy between personal safety devices and technology exemplifies a progressive approach to addressing societal challenges, reaffirming the potential of innovation to contribute to the well-being and empowerment of individuals, particularly women, in their daily lives. In conclusion, the incorporation of GPS tracking and alerts in personal safety devices utilizing Arduino technology represents a commendable stride towards fostering women's safety. As technology continues to evolve, the synergy between innovation and personal security endeavors to create a world where individuals, irrespective of gender, can navigate their surroundings with confidence and resilience against potential threats [1 - 3].

In an era where personal safety is a paramount concern, especially for vulnerable individuals such as children and women, technological innovations play a crucial role in providing effective solutions. This book chapter explores the intricacies of the "Safety Device using IoT," a comprehensive system designed to address emergency situations and enhance the security of individuals in distress. Comprising key components such as the Arduino Nano, NEO6M GPS module, GSM technology, SOS button, RF transmitter, and RF receiver, this safety device represents a cutting-edge application of the Internet of Things (IoT) in ensuring personal safety [4 - 6].

Components Overview

Arduino Nano with Atmega 328P Microcontroller

It serves as the central processing unit, facilitating the integration and coordination of various components, and enables seamless communication between different modules and sensors.

NEO6M GPS Module

It provides accurate global positioning system (GPS) data for precise location tracking and enables essential real-time monitoring of the victim's location during distress.

GSM (Global System for Mobile Communication)

It facilitates communication by sending messages and making calls to pre-registered phone numbers and enables a reliable and immediate alert mechanism.

SOS Button

It functions as the trigger for activating the safety device in emergencies and is designed for easy operability, ensuring quick response during distress.

RF Transmitter and RF Receiver

It enables seamless communication within the system, enhancing the overall reliability of the safety device and contributing to the comprehensive communication infrastructure of the device. Fig. (**1**) shows Architectural overview of Women's security devices with IoT connectivity.

CHAPTER 10

Ethical Data Practices in Digital Health: A Patient-Centric Future in Society 5.0

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Abstract: The healthcare sector has seen a change because of the quick development of digital health technologies, which provide a wealth of advantages and prospects. But with all of this digital change, there are also significant ethical questions about how healthcare data is gathered, stored, and used. This chapter examines the relationship between data ethics and digital health, emphasizing the main obstacles to ethical and responsible activities as well as possible solutions. It explores issues including informed consent, patient privacy, data security, and the moral ramifications of AI and machine learning algorithms [1] in the healthcare industry. This chapter intends to provide a greater knowledge of the significance of data ethics in creating a reliable and patient-centric digital healthcare ecosystem by exploring the ethical aspects of digital health.

Keywords: Consent and transparency, Data privacy, Data security, Digital health, Ethical consideration.

INTRODUCTION

Over the last few years, the electronic change in the medical care sector has brought about a substantial rise in the collection, and storage space coupled with the use of individual information. While this change has produced various advantages it has likewise increased worries concerning the ethical consequences of managing delicate wellness details. As the assimilation of modern technology in medical care continues to progress, the value of ethical data practice in electronic health cannot be exaggerated.

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Most importantly ethical data practices are crucial for promoting individual privacy as well as discretion. In the electronic age, substantial quantities of individual wellness information are being created and shared throughout different systems consisting of digital wellness documents, wearable tools, as well as telemedicine applications. It is important that medical care companies along with modern technology suppliers comply with stringent moral criteria to make certain that individual information is protected from unapproved accessibility, abuse, or exploitation.

Furthermore, ethical information methods play a vital function in advertising openness as well as responsibility within the electronic health landscape. Medical care suppliers as well as modern technology designers need to be clear regarding exactly how individual information is gathered, saved as well as made use of, in addition to the objectives for which it is being used. Moreover, clear and easily accessible plans pertaining to information administration and grants equip individuals to make enlightened choices regarding the sharing of their wellness details. By developing durable ethical structures and administration devices, the liable handling of information can be made sure therefore mitigating the threat of information violations as well as unapproved information handling.

In addition, the ethical use of information in electronic wellness is carefully connected to the innovation of clinical research study and the distribution of tailored treatment. By leveraging de-identified and accumulated wellness information in a liable fashion, scientists along with healthcare experts can obtain useful understandings right into condition patterns, therapy results as well as populace wellness patterns. Honest information techniques make it possible for the accountable sharing of information for research study objectives adding to the growth of evidence-based medical treatments as well as the renovation of individual results. Additionally, the ethical evaluation of specific individual information can sustain the shipment of tailored as well as accurate medication promoting customized therapy that straightens with the special demands of people.

The ethical information is basic to the ethical and also accountable improvement of electronic wellness. By maintaining concepts of personal privacy, openness as well as responsibility, healthcare stakeholders can grow an atmosphere of dependence along with honesty in making use of client information. Accepting ethical information methods not only safeguards clients' privacy but also fosters advancementand distribution of patient-centered treatment [2]. As electronic wellness continues to transform the medical care landscape, the honest factors to consider bordering information techniques have to continue to be at the center of sector campaigns making certain the ethical structure of electronic wellness for the advantage of clients and culture as a whole.

CONTRIBUTION OF THE CHAPTER

- To explore the different patient-centric approaches to data in digital health
- To know different ethical data practices in digital health
- To discuss the ethical considerations in the future of digital health
- To discuss best practices for data handling in digital health

This chapter has been organized into nine sections. The first section describes the motivation for this chapter. The second section represents the patient-centric approach to handling data in digital health care. The third section represents ethical practices for ensuring privacy and trust. Section third represents the ethical data practices in the digital health landscape, and the fourth section describes ethical considerations in the future of digital health. The fifth and sixth section describe ethical data practices and empowering patients in digital health care. The seventh section represents the role of ethical data practices. Best practices for data handling are described in section eighth. Balancing data practices and privacy is described in section nine followed by the conclusion.

MOTIVATION

We envision a future in which technical developments in electronic health and wellness have permitted it to be efficiently incorporated right into every component of our lives. In this instance, individuals have access to personalized wellness information allowing them to make educated choices concerning their health and wellness.

The motivation of this article comes to be noticeable in this setup. As the situation plays out, we witness a culture in which individuals' health and wellness details are valued not simply for their wellness but likewise for the enhancement of public wellness projects coupled with clinical study.

The circumstance establishes the phase for discovering the vital significance of personal privacy, permission, as well as openness in the collection, storage space, and utilization of health and wellness information. It highlights the possible advantages of leveraging this information for customized medication and also populace health and wellness monitoring while highlighting the demand for durable moral structures to guarantee that people's civil liberties and freedom are shielded.

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