EMERGING COMPUTATIONAL APPROACHES IN TELEHEALTH AND TELEMEDICINE

A LOOK AT THE POST COVID-19 LANDSCAPE

Editors:

G. Madhu

Sandeep Kautish

A. Govardhan

Mathura Prasad Thapliyal

Avinash Sharma

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Emerging Computational Approaches in Telehealth and Telemedicine: A Look at The Post COVID-19 Landscape

(Volume 1)

Advances in Data Science-Driven Technologies

Edited by

G. Madhu
Department of Information Technology
VNR Vignana Jyothi Institute of Engineering & Technology
Hyderabad- 500 090, Telangana,
India

Sandeep Kautish
LBEF Campus, Kathmandu (Nepal)
(In Academic Collaboration with Asia Pacific University),
Malaysia

A. Govardhan
Professor of Computer Science & Engineering
and Rector Jawaharlal Nehru Technological University
Hyderabad-500085, India

Mathura Prasad Thapliyal
Department of Computer Science & Engineering
School of Engineering & Technology, Post Box- 54
HNB Garhwal University, (A Central University),
Srinagar (Garhwal) Uttarakhand, INDIA

Avinash Sharma
Principal & Professor,
Maharishi Markandeshwar Engineering College,
Mullana, Ambala (Haryana) Constituent
institution of Maharishi Markandeshwar University,
Mullana, India

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PREFACE

This book aims to compile innovative methods and literature related to telehealth and telemedicine that will assist in determining whether there is a need or urgency to intervene, as well as the risk to healthcare workers. Telehealth refers to a wide range of technology and services used to provide patient care and improve the overall healthcare delivery system. Telehealth is distinct from telemedicine because it encompasses a broader range of remote healthcare services.

The content presented in this book offers a variety of methods/techniques that will provide an effective and sustainable solution for precaution, prevention, and treatment to stem the spread of the COVID-19 virus. The Internet of Things (IoT) in Telemedicine, Artificial Intelligence for Remote Patient Monitoring System, Convolutional Neural Networks for Skin lesions prediction, Telemedicine with machine learning, Covid-19 virus contact tracing via mobile app, IoT and Cloud convergence in healthcare exploration analysis, and Lung cancer classification and detection using deep learning technique, have all been thoroughly covered. This edited book also sheds light on upcoming trends, challenges, and future research directions in telehealth and telemedicine for the control of infectious diseases. We editors believe that this book will help the researchers, students, academicians, and medical practitioners know and adopt state-of-the-art technologies in telemedicine.

We would like to express our heartfelt gratitude to our reviewers, who have helped despite their hectic schedules. Thank you very much to all our authors for submitting their work. We would like to express our heartfelt gratitude to Bentham Science Publishers for accepting our proposal to edit this book and for their unwavering support throughout the editing process. Thank you to everyone who has contributed, directly or indirectly, to the completion of this edited book.

We believe the efforts we rendered for editing the book are worthwhile only if this book is of any use to the ordinary end-users of our society. This gratification will motivate us to produce more edited publications that will benefit society.

G. Madhu
Professor, Department of Information Technology
VNR Vignana Jyothi Institute of Engineering
& Technology Hyderabad- 500 090,
Telangana, India

Sandeep Kautish
LBEF Campus,
Kathmandu (Nepal)
In Academic Collaboration with Asia Pacific University,
Malaysia

List of Contributors

Ankit Raj Gaddam	Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology Pragathi Nagar, Hyderabad, India-500090
Avinash Sharma	Maharishi Markandeshwar Deemed to be University, Ambala, Haryana, India
Aashrita Roy P	Department of EIE, VNR Vignana Jyothi Institute of Engineering and Technology, Pragathi Nagar, Hyderabad-500090, India
Apoorva D	UG Scholars, Department of Information Technology, PSG College of Technology, Tamil Nadu, India
Boppuru Rudra Prathap	Department of Computer Science and Engineering, CHRIST (Deemed to be University), Kanminike, Bengaluru – 560074, Karnataka, India
Brahmananda Reddy. A	Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Pragathi Nagar, Hyderabad, India-500090
B V Kiranmayee	Department of Computer Science and Engineering VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad, India
Ch. Priyank	Department of EIE, VNR Vignana Jyothi Institute of Engineering and Technology, Pragathi Nagar, Hyderabad, India- 500090
Deepak Sukheja	Department of Computer Science and Engineering VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad, India
Durgesh Mishra	Professor (CSE) and Director Sri Aurobindo Institute of Technology, Indore, MP, India
Girish P. Bhole	Associate Professor, Veermata Jijabai Technological Institute, Matunga, Mumbai, India
Hari Murthy	Department of Electronics and Communication Engineering, CHRIST (Deemed to be University), Kanminike, Bengaluru – 560074, Karnataka, India
Junhua Ding	Department of Information Science, University of North Texas, Denton, Texas, USA
Javeriaya Fathima	Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Pragathi Nagar Hyderabad, India-500090
Jeevan Galipelli	Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Pragathi Nagar, Hyderabad, India-500090
Kukatlapalli Pradeep Kumar	Department of Computer Science and Engineering, CHRIST (Deemed to be University), Kanminike, Bengaluru – 560074, Karnataka, India
Mani Kumari	Mechanical Department, Osmania University, Hyderabad, India
Moushita Patnai	School of Computer Engineering, Kalinga Institute of Industrial Technology, Deemed to be University, Bhubaneswar, Odisha, India
Muhil Varsini S	Department of Information Technology, PSG College of Technology, Tamil Nadu, India

Malaya Nayak	IT Buzz Ltd, Executive Director, 6th Floor, Whitehall House, 41 Whitehall, London SW1A 2BY
Ravi B	Department of EIE, VNR Vignana Jyothi Institute of Engineering and Technology, Pragathi Nagar, Hyderabad, India- 500090
Seema Yadav	Veermata Jijabai Technological Institute, Matunga, Mumbai, India
Sharmila K.	Department of CSE, Vaagdevi Engineering College, Warangal, Telangana, India
Sravanthi T.	Department of CSE, Vaagdevi Engineering College, Warangal, Telangana, India
Subitsha T	UG Scholars, Department of Information Technology, PSG College of Technology, Tamil Nadu, India
Sunil Kumar Talluri	Department of Computer Science and Engineering VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad, India
Sagar Yeruva	Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Pragathi Nagar, Hyderabad, India-500090
Sunil Shatagopa	Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Pragathi Nagar, Hyderabad, India-500090
Srujana Gundu	Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Pragathi Nagar, Hyderabad, India-500090
Sushruta Mishra	School of Computer Engineering, Kalinga Institute of Industrial Technology, Deemed to be University, Bhubaneswar, Odisha, India
Vinay Jha Pillai	Department of Electronics and Communication Engineering, CHRIST (Deemed to be University), Kanminike, Bengaluru – 560074, Karnataka, India
V. Janaki	Department of CSE, Vaagdevi College of Engineering, Warangal, Telangana, India

CHAPTER 1

Applications of Internet of Things in Telemedicine

Kumari K Anitha[1,*], Avinash Sharma[2], T Subitsha[1], Varsini S Muhil[1] and **D Apoorva[1]**

[1] *Associate Professor, UG Scholars, Department of Information Technology, PSG College of Technology, Tamil Nadu, India*

[2] *Professor, Department of Computer Science and Engineering, Maharishi Markandeshwar University, Mullana, Haryana, India*

Abstract: The term 'telemedicine' is referred to as healing remotely with the help of digital technologies by healthcare providers to detect and treat sufferers. Due to necessary physical distancing and lack of appropriate treatments during the Covid-19 pandemic times, telemedicine has proven to be a secure interactive mechanism between patients and medical professionals. The telemedicine framework is part of the Internet of Medical Things (IoMT) since it allows many medical devices to connect and share data. IoT has a lot of benefits in Telemedicine. It aids doctors in gaining access to vital data from medical devices, real-time monitoring of patients, assisting sick and elderly people, and distant medical support. Apart from benefits for patients, it also benefits hospitals and insurance companies. Moreover, distant monitoring of a patient's condition tends to shorten hospital stays. It has a huge effect on lowering healthcare costs and enhancing treatment methods. Many wearable devices, like heart rate monitoring devices, blood pressure monitoring devices, glucometers, *etc*., provide a way to access the patient's health information. The proposed study revealed different applications of IoT in healthcare for various diseases and disorders, various medical sensors, and notable wearable devices in healthcare.

Keywords: Internet of Medical Things (IoMT), Internet of Things, IoT healthcare, Medical sensors, Telemedicine.

INTRODUCTION

The world has shrunk in size as a result of technological advancements, and individuals increasingly interact with things as well as other people. Everything may now be internet-connected due to the Internet of Things.

[*] **Corresponding author Anitha Kumari K:** Associate Professor, UG Scholars, Department of Information Technology, PSG College of Technology, Tamil Nadu, India; Tel: +91-9842525820; E-mail: anitha.psgsoft@gmail.com

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The Internet of Things connects multiple devices. As a result, this notion makes life much easier for humans. Since the Middle Ages, one of the most pressing issues people have faced has been health.

Even though health conditions are becoming more prevalent, the globe lacks sufficient health professionals to address them. Health issues are one of the major concerns of governments and organizations in developing economies. A key issue is a lack of facilities to provide home therapy. It has piqued the interest of IoT experts, and it is the most promising option we have since IoT allows people to control their health problems while still receiving assistance in critical situations. Doctors, on the other side, can simply manage and consult patients.

Numerous innovative IoT apps have been created to assist doctors and healthcare officials throughout the years. IoT aids healthcare in providing better functionality by enabling patient administration, medical recordkeeping, healthcare emergency preparedness, treatment supervision, and other services, all of which contribute to the overall quality of service applications. IoT is used in hospitals to continually monitor patients and deliver real-time health care services.

The IoT can properly track people, services, and objects. As a consequence, examining the data yields precise findings. As in the health sector, precise data leads to the most effective treatments. Through IoT, clinicians may use connected instruments to monitor vital signs as well as other biometric data of patients. As a result, illnesses and issues might be identified rapidly. IoT allows hospitals and ambulance services to be alerted rapidly whenever patients want their services. Additionally, IoT allows roads and traffic signals to be regulated to enable ambulances to get to the clinic fast.

The quick increase in population has created several obstacles for health care, eventually resulting in a lack of healthcare resources. It is critical to tackle these problems and give a quick remedy based on minimal available resources. Because of its ease of use, IoT, smartphone, and internet connectivity give the greatest option. The primary goal of IoT-based medical care is to deliver a great user experience at a reasonable cost while also improving the quality of life. The main purpose of the Internet of Things is to link patients with chronic conditions to access healthcare resources and to offer them trustworthy, efficient, and intelligent healthcare services [1].

Mobile computing, in turn, delivers services to IoT through mobile phone services, applications, and the m-health medical system. M-health helps the Internet of Things by providing features such as portability, IP connection, low battery utilization, and security. IoT can keep people healthy by reminding them to perform the essential steps to stay healthy. People are familiar with smart

wearable gadgets. IoT can maintain physical fit by reminding them to take the essential steps to stay healthy. People are familiar with wearable medical gadgets, and they have influenced the wellness domain [2].

Physicians can communicate with patients more effectively than before with such facts, and people are happy with their treatments. Even though IoT promises to enhance patient care, increase healthcare services and workflows, continually enhance, and generate cost reduction, there are enough challenges to solve. Confidentiality, security, availability, and technical difficulties were among the challenges. IoT is indeed a relatively new idea like many health care providers and patients, particularly the aged, who stand to profit from it more. The application of IoT in medical care, on the other hand, is unavoidable [3].

IOT ARCHITECTURE FOR THE HEALTHCARE DOMAIN

There is no broadly agreed-upon structure for the Internet of Things. Several researchers have identified various designs [4 - 6].

Fig. (**1**) shows the five-layered architecture of IoT. The IoT framework in health care delivery is made up of five main levels they are,

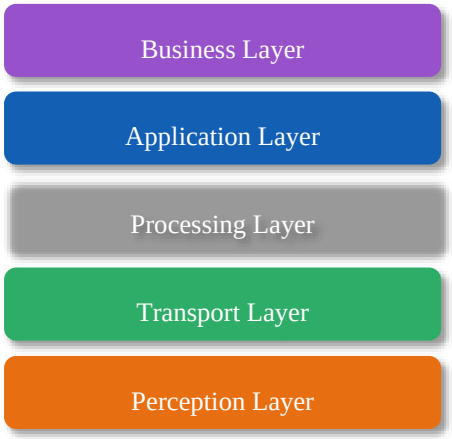

Fig. (1). Five layered architecture of IoT.

Perception Layer

The physical layer, which contains sensors for perceiving and receiving information about the surroundings, is the perception layer. It detects physical characteristics or recognizes other smart things in the surroundings. Its capabilities are also employed to receive and interpret sensor data.

CHAPTER 2

Adopting Artificial Intelligence for Remote Patient Monitoring and Digital Health Care

K. Sharmila[1,*], **V. Janaki**[2] and **T. Sravanthi**[3]

[1] *Department of CSE, Vaagdevi Engineering College, Warangal, Telangana, India*

[2] *Department of CSE, Vaagdevi College of Engineering, Warangal, Telangana, India*

[3] *Department of CSE, Vaagdevi Engineering College, Warangal, Telangana, India*

Abstract: The COVID-19 pandemic has created a new culture in the working style in all fields across the globe. While trauma is continuing to rise in many parts of the world, some countries are now working to sustain the stress and are recreating their health and economies. In a few developing countries, there is a shortage of doctors, and treatment is not being provided to all patients due to the lack of time that doctors can spend with patients. In such a situation, getting appointments and treatment is always a challenge for patients and elderly people who cannot resist longer waiting times. Another rising problem is the restriction on visiting the hospitals during the pandemic spread time, except in emergencies. To overcome this problem, we are proposing a Remote Health Monitoring Application for patients, which helps all categories of people consult the doctor over the telephone, explain their symptoms, and get their required treatment. In this chapter, we will discuss a Health Monitoring Application that employs Artificial Intelligence, which enables the patient to consult the doctor remotely and get treatment through digital mode.

Keywords: Artificial Intelligence, Digital Health Care, Remote Health Monitoring Application, Telemedicine.

INTRODUCTION

The implementation of Artificial Intelligence in the field of health informatics enhances the provision of improving the quality and effectiveness of the decision-making process regarding the health condition of a patient. Its integration in treating a patient remotely, not only supports collecting the complete health-related information about the patient, but also in analyzing the health record by learning from the real-time data. This automatically can make improvements in making predictions on the patient's health condition in the near future [1].

* **Corresponding author K. Sharmila:** Associate Professor, Department of CSE, Vaagdevi Engineering College, Warangal, Telangana, India; E-mail: sharmilakreddy@gmail.com

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In a remote health monitoring system, the patient suffering from ill health can get an appointment online and get treated by a doctor. Based on the condition of the patient, he will be under the remote observation of the doctor [2].

The remote health monitoring system and digital health care present an effective solution to control and monitor a growing number of patients, especially elderly patients and those people who require emergency health support [2]. They can be implemented with Artificial Intelligence and the Internet of Things, operated with an application installed on a mobile phone. They can be connected to a wearable device that establishes a connection between the device and the patient, thereby generating visual analytics for gaining insight into the patient's information [3].

A few decades ago, gaining access to all the information through our fingertips was a distant dream. Nevertheless, the world has witnessed revolutionary changes in the recent past, leading to the complete transformation of our lives [4 - 6]. The world of computers and Information Technology has risen completely and has now led to Industry 4.0, the amalgamation of recent trending technologies like Cloud Computing, Internet of Things, Artificial Intelligence, Machine Learning, Cognitive Computing, Cyber Security, and many more. The inclusion of all these technologies in our daily routine has created a niche for a new digitalized lifestyle [5, 6].

Artificial Intelligence and the Internet of Things are the cutting-edge technologies in this era that enable electronic gadgets and devices to perform cognitive tasks like human beings. These tasks include understanding, identifying, thinking, learning, problem-solving, and decisions making. It was initially developed as a technology that can act with human intelligence, but it got progressed in many ways, more than expected. The usage of the Internet has been growing radically, and so has the amount of data storage on the cloud, which has created an implausible advancement in data collection, processing, and computation power. The human-alike intelligent systems are able to be adapted over diverse areas, thus enabling connectivity through the Internet of Things [4, 5].

As the capability of Artificial Intelligence algorithms and their implementation have been intensively growing, its utilization is also being expanded to many fields, which was possible through the true transformation ability of the technology. While Artificial Intelligence has a true potential to transform technology in diverse areas, its adaption to a specific sector provides an opportunity to fulfill the needs of that sector by including the emerging technology [5]. Artificial Intelligence can benefit many sectors like Healthcare, Agriculture, Education, Transportation and Logistics, Traffic management, Smart

Cities, Smart Home Automation, Smart kitchens and Appliances, and many more [6].

Artificial Intelligence, combined with the Internet of Things is a cluster of technologies that allows devices to act with advanced levels of intellect and perform the same tasks as human abilities of sensing, understanding, and acting accordingly. This process thereby enables the audio and video processing of the device to actively observe and distinguish the world around it by acquiring and processing data in terms of images, sound, and speech [7, 8]. Human-like abilities are applied by learning from past experiences and getting adapted. Every application has lots of data, which is one of the main driving sources for Artificial Intelligence and IoT solutions, and it is always a challenge to handle a large amount of data, ensuring privacy and security [8]. In this chapter, we discuss different methods of implementing Artificial Intelligence in diverse areas of health care, especially in the field of telemedicine.

LITERATURE SURVEY

Health care plays a vital role and forms a major part of a nation's development. The COVID-19 pandemic has brought a lot of changes in the lives of people across the globe. Every country is conducting a lot of research in health care and is focussing on treating illness. The world is now undergoing a revolutionary transformation towards health-based research and approaches. As Artificial Intelligence is an emerging technology, it is very important to understand and analyze how it can be implemented and applied with reference to the healthcare context. Artificial Intelligence provides automation and recommendations through a wide variety of tools and visualizes the data for easy understandability of the user [9, 10].

Overview of Telemedicine

Telemedicine can be defined as the usage of cutting-edge technologies in the health sector perspective to reduce the time and effort taken by the patient to meet a doctor personally. The technology used to bridge the gap of distant medical assistance using communication and technology benefits both the doctor and the patients too. It came into existence during the last century itself [11 - 13].

Telemedicine provides health services to people who seek healthcare facilities through information technology and the Internet. It reduces the time and travel between the doctor and patients. Usage of Telemedicine had come to arise during the COVID-19 pandemic when the general public was not permitted to go out for a visit to a doctor due to the guidelines framed by the respective national governments [4, 14]. It is mainly used to overcome the travel time and waiting

CHAPTER 3

Prediction of Skin lesions (Melanoma) using Convolutional Neural Networks

Deepak Sukheja[1,*], B V Kiranmayee[1], T. Sunil Kumar[1], Malaya Nayak[2] and **Durgesh Mishra[3]**

[1] *Department of CSE, VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad, India*

[2] *IT Buzz Ltd, Executive Director, 6th Floor, Whitehall House., 41 Whitehall, London*

[3] *Sri Aurobindo Institute of Technology, Indore, MP, India*

Abstract: Nowadays, computational technology is given great importance in the health care system to understand the importance of advanced computational technologies. Skin cancer or skin disease (melanoma) has been considered in this chapter. As we know, the detection of skin lesions caused by exposure to UV rays over the human body would be a difficult task for doctors to diagnose in the initial stages due to the low contrast of the affected portion of the body. Early prediction campaigns are expected to diminish the incidence of new instances of melanoma by lessening the populace's openness to sunlight. While beginning phase forecast campaigns have ordinarily been aimed at whole campaigns or the public, regardless of the real dangers of disease among people, most specialists prescribe that melanoma reconnaissance be confined to patients who are in great danger of disease. The test for specialists is the way to characterise a patient's real danger of melanoma since none of the rules, in actuality, throughout the communities offer an approved algorithm through which melanoma risk may be assessed. The main objective of this chapter is to describe the employment of the deep learning (DL) approach to predict melanoma at an early stage. The implemented approach uses a novel hair removal algorithm for preprocessing. The k-means clustering technique and the CNN architecture are then used to differentiate between normal and abnormal skin lesions. The approach is tested using the ISIC International Skin Imaging Collaboration Archive set, which contains different images of melanoma and non-melanoma.

Keywords: Convolutional Neural Networks, Deep Learning, Hair Removal, Melanoma, Sequential Model, Skin Lesions.

[*] **Corresponding author Deepak Sukheja:** Associate Professor, Department of CSE, VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad, India; E-mail: deepak_s@vnrvjiet.in

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INTRODUCTION

DEEP LEARNING METHODS FOR HEALTH CARE

Deep Learning (DL) and machine learning (ML) are tightly coupled and have been used in many applications of AI in image analysis, radiology, *etc.* Health care is the most important sector to be focused on uplifting human life. Nowadays, most of these things are implemented with many advancements as many people are using the internet rapidly for different purposes. There are many other applications in different domains to make the process of doing the tasks easier. Likewise, in health care, we have some applications like medicine delivery, online appointment booking, telemedicine, smart wrist bands, digital BP apparatus, digital oximeters, glucometers, *etc* [1]. These kinds of advancements reduce the need for human analysis of a sample of data. By making the applications work smart, human intervention is gradually reduced even in diagnosis, quantification, planning, monitoring, reconstruction, analysis, medical reporting, *etc.* DL is one such approach that helps in the analysis as a human does. To analyse the data, the layered architecture, *i.e.*, neural networks, is used. The tasks of mathematical translation are done to turn the raw input into a meaningful one [2].

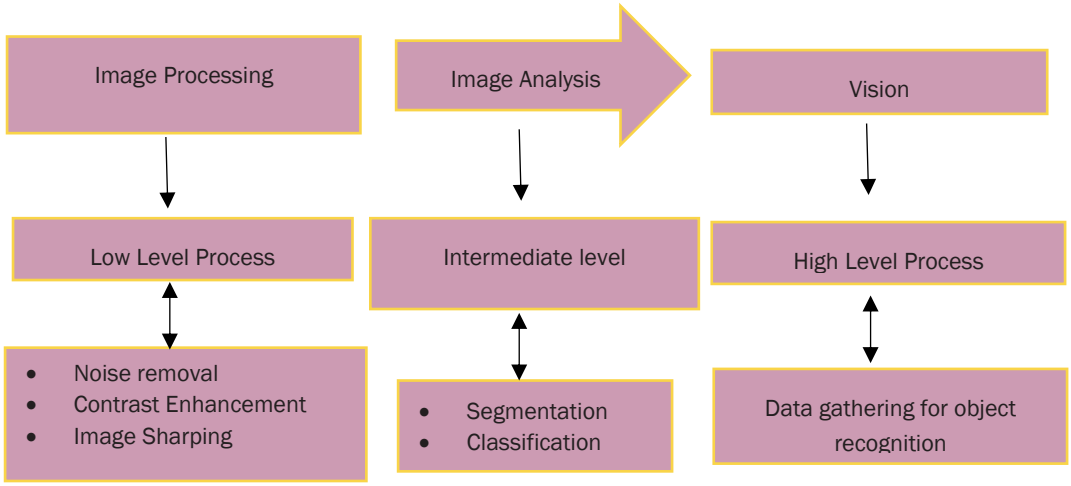

Fig. (1). Illustration of the Image analysis process.

Radiology, the department of diagnosing diseases, has its challenges. At times, few diagnoses cannot be made with the help of a human's naked eye. It is required to analyze the image of the affected portion of the body to diagnose it correctly at an earlier stage of the disease. To implement this without any human intervention (sometimes humans also make mistakes), the image analysis that

involves the image pre-processing followed by the analysis, helps us diagnose the disease [3]. The phase-wise process of image analysis is shown in Fig. (**1**).

In the process analysis, the digital image processing is done in different steps, as shown in Fig. (**2**) below.

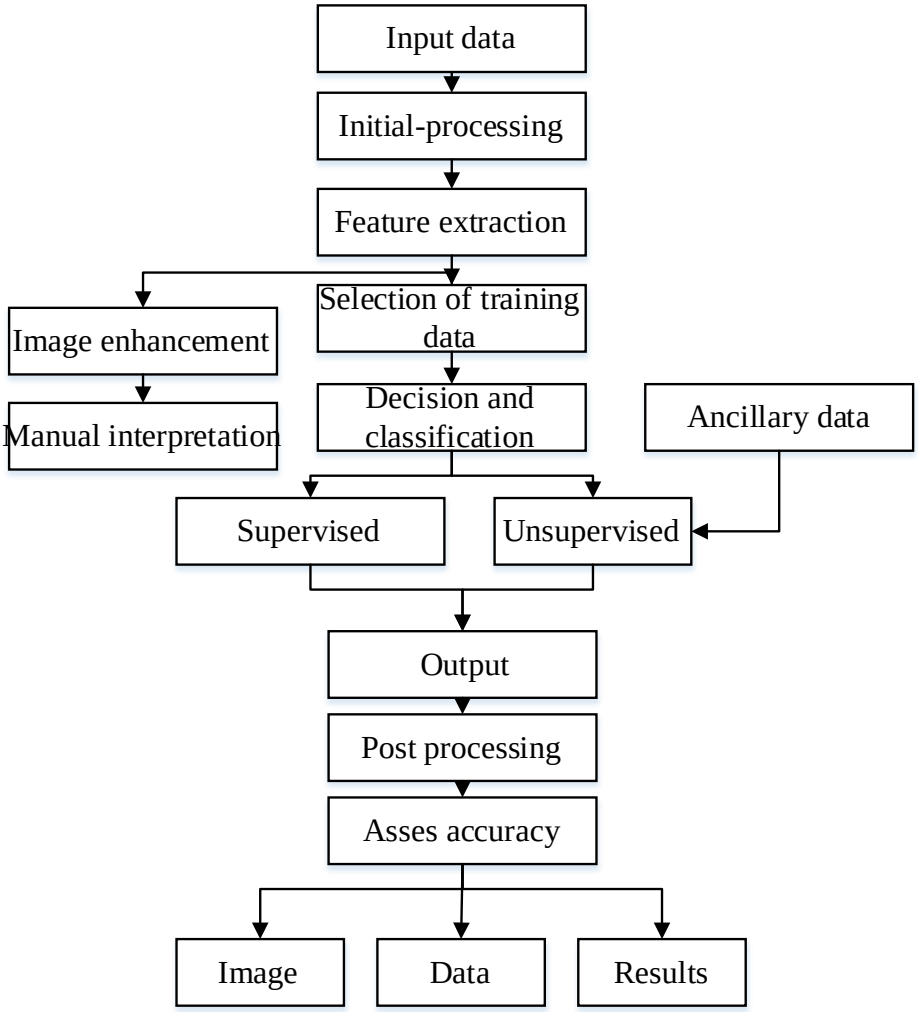

Fig. (2). Stage-wise flow diagram of Digital Image Processing.

CHAPTER 4

Telemedicine using Machine Learning: A Boon

Seema Yadav[1,*], **Girish P. Bhole**[1] and **Avinash Sharma**[2]

[1] *Veermata Jijabai Technological Institute, Matunga, Mumbai, India*

[2] *Computer Science Department, Maharishi Markandeshwar Deemed to be University, Ambala, Haryana, India*

Abstract: Telemedicine is a part of e-Health that employs information communication technologies (ICT) to transmit healthcare information required for educational and therapeutic purposes. Telehealth attempts to overcome the challenges in the delivery of health services due to distance, time, and challenging landscapes. It plays a significant role during floods and earthquakes. It enables better access and cost-effectiveness in both developing and developed world locations. The health sector has been dramatically influenced and affected by the Covid-19 pandemic with the adoption of improved technology that has allowed many people to access healthcare from the comfort of their homes. Remote follow-up and monitoring are also provided through Telemedicine as postoperative care. The possible scope and application of Artificial Intelligence techniques in the Telehealth area are discussed in this paper. The paper also focuses on different computational solutions involving machine learning and Artificial Intelligence to tackle the crisis. The methods focus on two major areas: 1) improvement in the quality of existing clinical practices, and service delivery. 2) the growth besides the support of innovative models for healthcare. The methods to improve quality include digital storage of patient data and large datasets, automation of manual tasks for CT scans, conducting X-rays and handling the emergency, and electronic consultation for diagnosis, treatment, and monitoring of patients. Innovative methods such as ICT and technology such as accelerometers, GPS, gyroscopes, motion sensors, and so on, are used in healthcare.

Keywords: Artificial Intelligence, E-Health, Healthcare, ICT, Machine Learning, Remote Monitoring, Telehealth, Telemedicine.

INTRODUCTION

Telemedicine is communication with care providers or doctors through email or sharing of medical information online. It is a component of e-Health that uses communication technology and information for the conveyance of well-being care facilities to overcome distance and connect patients with doctors or providers.

[*] **Corresponding author Seema Yadav:** Veermata Jijabai Technological Institute, Matunga, Mumba, India; E-mail: ssyadav _p17@ce.vjti.ac.in

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Telehealth is not about the patient and the treatment provided by the doctor but also provides the knowledge of equipment [1]. In the United States, practicing *telemedicine* has a long history. At the beginning of 1960, NASA funded a Telemedicine project to provide healthcare to astronauts in space. In rural areas, since 1999, the Medicaid Service Centre has provided distant contact to specialists to meet the requirements of patients. Outpatient telemedicine services are only paid half the price of in-person specialist appointments. The spender is more worried approximately the increasing expenses of patients getting to healthcare regularly than they might be something else. Since we were all forced to stay at home during the Covid-19 outbreak, the Center for Medicare has made telemedicine a viable option for all patients.

Using mobile and wireless technologies is referred to as *mHealth* when we talk about telemedicine. Nowadays, there are many mobile applications that offer a range of services like mental and medical healthcare, health tips, reminders, and remote following of crucial signs utilizing our gadgets. These facilities perceive artificial intelligence and machine learning to provide solutions for problems that have afflicted healthcare.

In this chapter, we'll discuss numerous approaches that the healthcare framework has resisted to provide the highest level of service quality, as well as the usage of machine learning to improve the methods that are required to give healthcare. While discussing the usage of artificial intelligence in healthcare applications, various ethical issues are required.

WHAT IS TELEMEDICINE?

Comparing telemedicine with physical consultation, where patients visit the clinic or hospitals nonetheless, rather than talking to the physician personally, telemedicine allows patients to have conversations with the specialist using video as well as audio, thus the patient visits the specialist virtually. IT technologies are used to distribute health-related services. Thus, *telemedicine* is a part of telehealth.

A telemedicine network involves three ends: 1) the communication link, 2) the patient end, and 3) the specialist's end. Since a significant amount of Indian citizens reside in rural areas, accessibility to appropriate healthcare facilities could be a challenge. In such cases, telemedicine plays an important role. Nevertheless, the Indian business needs to address numerous problems in advance so that telemedicine can become the standard.

Telemedicine helps facilitate the effective delivery of medical care in isolated areas, aging populations, and vulnerable groups for teleconsultation and Tele-

education for the local doctors [2]. It is also helpful in postoperative care through remote monitoring and follow-up [3, 4]. An effective telemedicine initiative requires an active ecosystem comprised of patients, care providers, participating hospitals within the network, and information technology. Pre-emptive telemedicine governance helps to ensure an effective healthcare delivery system and improve the quality of experience.

Need of Telemedicine

Medical experts are currently experiencing a great deal of difficulty. Firstly, there is extensive unavailability of doctors and nurses. The fact is that the doctors are very busy and don't have ample time to spend with the patients. It becomes difficult for them to gather the satisfactory history of the patient, which could be dangerous for appropriate findings and treatment. In addition to this, doctors cannot promise their crucial time to update themselves with the most recent cutting-edge findings in medicine. The actual study revealed that for analysis of all significant and latest literature [3], a primary care physician would take 29 hours per weekday. Due to this, the patients are receiving incorrect diagnoses besides the required quality treatment.

From the patient's point of view, it could be challenging to search for a specialist providing premier quality treatment. In rural areas, finding a doctor can be a challenging task. Moreover, some patients can't afford the fees of visiting doctors.

According to the most recent assessment of current telehealth advancements, there are two motivations for change:

1. High volume demand and associated data become more challenging due to the physical gathering of patients, and clinicians.

2. Applications with high criticality, in which highly specialized competence is needed now at a particular time for the medical requirement.

Telehealth can use ICT tools to report concerns with unsatisfied demand for healthcare services compared to supply. Artificial Intelligence (AI) can help solve this challenge by using complex algorithms to match the availability of a healthcare professional with relevant medical competence to the use of such experience in the immediate area.

Telehealth has many operational issues, such as the communications link going down or if the doctor is unavailable physically. AI may help in such situations by giving ways in-person or digital communications, addressing the issues that

CHAPTER 5

CoviCare: An Integrated System for COVID-19

Sagar Yeruva[1,*], Junhua Ding[2], Ankitraj Gaddam[1] and **A Brahmananda Reddy[1]**

[1] *Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Pragathi Nagar, Hyderabad, India- 500090*

[2] *Department of Information Science,University of North Texas, Denton, Texas, USA*

Abstract: Pandemics are large-scale infectious disease outbreaks that can dramatically increase morbidity and mortality over a wider geographic region and trigger substantial economic, social, and political damage. Currently, the world is facing the coronavirus (COVID-19) pandemic. COVID-19 is considered a dangerous disease affecting all entire humanity and reports death cases in the thousands each day (as per the source from Wikipedia, it is 3,690,000 deaths and 172,000,000 cases identified as COVID-19 positive as of 04-June-2021) and quietly throws dangerous bells on the entire humanity, causing health emergencies in every country, worldwide. Due to the ongoing pandemic, the healthcare infrastructure has been stretched. With the limited healthcare infrastructure and the number of COVID-19 cases spiking up, many countries have opted to treat their patients from the patient home, providing at-home medical facilities and continuous monitoring by medical officials at regular intervals. Health is of considerable importance in the new global situation. Providing smart healthcare is important for all people to monitor continuously and maintain good health. A powerful new mobile application and the usage of machine learning techniques can be an innovative solution to the healthcare problems in these pandemic times for patient management and disease management. This solution can directly impact clinical decision-making. The proposed mobile application is a utility tool for COVID-19 patients during and after the quarantine period/home isolation. This application is aimed at being a friendly interface that can record every detail of COVID-19 patient activity from the day of admission to the day of discharge. This facilitates the proposed system to record all symptoms, medication, responses to medicine, diet aspects, and physical and mental aspects of the patients. The proposed system is designed in such a way that we can get the data from the application that monitors the person's health activities, and that data will be used for the analysis to extract useful information by using machine learning techniques. The data that is collected from each patient is provided to the machine learning domain to find common features and patterns that help us to gain further insights into the disease and could help to develop better medications, vaccine development, immunisation knowledge base, recovery aspects,

* **Corresponding author Sagar Yeruva:** Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Pragathi Nagar, Hyderabad, India- 500090; E-mail: sagar_y@vnrvjiet.in

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and symptomatic approaches for the future generation. This knowledge extracted from the machine learning techniques can be used for better treatment and prediction of disease at the initial stages, which could mitigate the life risk and help to stop the spread of the disease.

Keywords: Coronavirus, CoviCare, COVID-19, Data Analysis, Data Collection, Machine Learning.

INTRODUCTION

The coronavirus outbreak has spread throughout the globe. The COVID-19 coronavirus pandemic is the most pressing global health catastrophe of our time in this century, posing the biggest threat to humanity since WWII. The virus has spread and conquered every continent in the world except Antarctica, after its first identification in Asia (China) in December 2019. The human family is bearing an almost unimaginable burden of loss, as we have already surpassed the horrific milestone of more than three million fatalities globally. However, in addition to being a health disaster, the pandemic is also a continuous socioeconomic calamity. It has the potential to have devastating social, economic, and political consequences in whatever country it strikes, leaving profound and long-lasting scars [1].

The rapidly rising incidence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [2] infections has necessitated a surge in public health efforts to better understand and characterise the new virus's epidemiology, considering infection risk factors and predictors of future consequences to gain a better understanding of the 2019 coronavirus disease (COVID-19) pandemic. The pandemic's rapid spread, on the other hand, poses an unprecedented challenge in terms of gathering exposure data to characterise the full scope of the epidemic's severity, thwarting efforts to disseminate reliable information on time to influence public health preparation and clinical management. An adaptable system for real-time data collection and analysis that encompasses the continuum of subclinical and acute presentations and addresses inequalities in diagnosis, treatment, and clinical performance is also urgently required. Taking care of this priority would enable more precise illness incidence estimates, risk-reduction measures to encourage the allocation of limited research resources, and proper quarantine and treatment for those impacted [3].

We believe that being able to forecast COVID-19 patients using clinical factors and a simple computer model would be extremely beneficial in solving the global shortage of COVID-19 testing capacity. Many governments and institutions are unable to provide adequate testing resources, leaving healthcare systems in a state of deprivation. Identification of the disease’s most happening hotspots and

targeted action against locations and individuals with the disease is one of their most potent tools for controlling the epidemic. The severity of the testing gap demands COVID-19 detection techniques that make use of available resources in local healthcare facilities. We propose developing a disease prediction model based on clinical factors and standard clinical laboratory testing.

Hence, producing a system that records all the activities of the patient with the mobile application and later using that data to create knowledge and insights into the disease will help the medical systems to provide proper care and facilities to curb the disease and end the pandemic, which also uplifts the socio-economic nature of the country.

The introduction section concludes here, and the next section introduces us to the related work done at the international level as well as at the national level, and the following section is about the proposed work with the working flow model, methodology design, and analysis of data. The next section is the implementation, which explains the detailed work of the proposed work. The closing section is the conclusion that concludes the work with references.

RELATED WORKS

International Status

In the current scenario, this virus is spreading from China (City of Wuhan) [4] and all over the world. Most countries are getting destroyed in all aspects, such as social, economic, and cultural communities, and they are having difficulties surviving their families, organizations, industries, and government sectors in any way. There is a need to analyse the pre and post-implications of COVID-19 and its associated viral infections on the respiratory systems in terms of health and wealth perspectives across the world [5].

The study [6] dated March 22, 2020, shows that the effect of COVID-19 will be felt more in the next few months/years. According to Dr. Ramanan Laxmi Narayanan of the Centre for Disease Dynamics in Washington and a lecturer at Princeton University, 30-50 crore people will be affected in India by July, with 10-12 lakh deaths, which is another alarming sign, particularly in the context of the Indian scenario.

The availability of health care, medicine, and other aspects like diagnosis methods is quite challenging. Among the three stages identified for COVID-19, the first stage and its early diagnosis are quite complicated and need to be done as soon as possible. The statistics also show the following [7] in Table **1**, where COVID-19 has its effects on people over 50 years of age. It will be more critical as the age is

CHAPTER 6

CoviCare: Current Trends and Challenges of Telemedicine in India: A Case Study on Patient Satisfaction.

Hari Murthy[1,*], Kukatlapalli Pradeep Kumar[2], Boppuru Rudra Prathap[2] and **Vinay Jha Pillai[1]**

[1] *Department of Electronics and Communication Engineering, CHRIST (Deemed to be University), Kanminike, Bengaluru – 560074, Karnataka, India*

[2] *Department of Computer Science and Engineering, CHRIST (Deemed to be University), Kanminike, Bengalur – 560074, Karnataka, India*

Abstract: The Indian economy has been witnessing remarkable economic growth in recent times, but the increasing healthcare overheads are still a major challenge. Telemedicine is a distant health service that uses electronic methods to diagnose, treat, and prevent disease and damage, as well as to conduct research and educate health care practitioners. Because of the diversified geography, challenging terrain, and a large number of people, it helps to bridge the gap between resources and demand in the healthcare system. It provides a chance for successful collaboration between primary and secondary healthcare centers, as well as reaching out to the rural masses. The Internet of Things (IoT), artificial intelligence (AI), machine learning (ML), and big data science have emerged as promising technologies. All patient data may be transferred to the cloud for continued monitoring, which can then be consulted by medical specialists at any time and from anywhere. With the increasing use of cyberspace for teleconsultation, data storage, data protection, and confidentiality obligations become imperative. The Telemedicine Guidelines of India (2020) are the first step in standardizing teleconsultation services in India. A case study was conducted to determine the level of satisfaction among the patients from the telemedicine aspect. A sample size of 100 individuals was collected on various parameters namely, age, marital status, education, gender, income, income category, and telemedicine satisfaction. IBM's SPSS tool was used to understand the statistical aspects. In almost all cases, the survey showed that the patients had good feedback which shows that telemedicine is the way forward where patients can consult with doctors in the comfort of their homes instead of visiting clinics. The goal of the chapter is to explore the current state of telemedicine in India, as well as its uses, problems, and future potential.

[*] **Corresponding author Hari Murthy:** Department of Electronics and Communication Engineering, CHRIST (Deemed to be University), Kanminike, Bengaluru – 560074, Karnataka, India; E-mail: hari.murthy@christuniversity.in

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Keywords: AI, Challenges, Data Science, Machine Learning, Telemedicine.

INTRODUCTION

It is often seen that a visit to the physician requires the person to take time off work or make childcare arrangements. People with persistent medical issues or a compromised immune system are vulnerable to acquiring an infection while at the doctor's office due to proximity to other patients. Healthcare delivery can be made more accessible by combining advanced technology with high-quality network services. The term telemedicine was first introduced in the 1970s and refers to remote healing. [1]. It is the use of ICT-Information and Communication Technology to improve patient outcomes by increasing remote access to treatment and medical information. Telemedicine is a more advantageous technology that can assist individuals to obtain preventative therapy and improve their long-term health. This is especially true for people who are unable to receive appropriate care due to financial or geographical constraints. The technology allows patients to get medical care at a time that is convenient for both the physician and the patient while ensuring that both the patient and caregivers are safe. Clinics have discovered that telemedicine helps them augment their revenue by allowing them to see more patients albeit at lower operating costs.

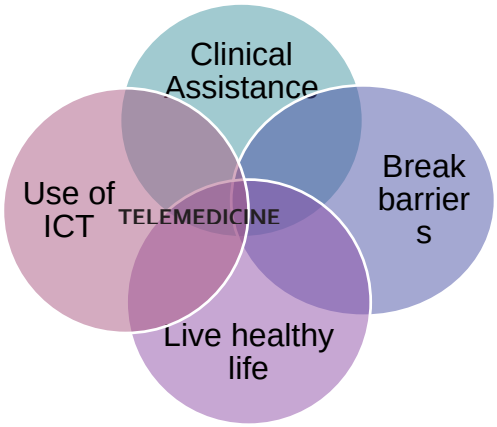

Fig. (1). Aspects of Telemedicine – The use of ICT for clinical assistance by breaking geographical barriers and allowing people to lead a healthy life.

People distinguish between telemedicine and telehealth, with the former referring to services only given by doctors and the latter referring to services provided by all health professionals, including nurses, pharmacists, and others. Fig. (**1**) depicts the four fundamental aspects of telemedicine – the use of ICT for providing

clinical assistance that would connect patients from remote locations to health care centers and help them live a healthy life. According to the Indian Medical Council, telemedicine is the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for the diagnosis, treatment, and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities. Tele-health is defined as the delivery and facilitation of health and health-related services including medical care, provider and patient education, health information services, and self-care *via* telecommunications and digital communication technologies [2].

Medical consultation, remote patient monitoring, and remotely guided treatment are parts of telemedicine in a nutshell [3]. Healthcare practitioners can evaluate, diagnose, and treat patients remotely utilizing digital communication technologies, eliminating the need for in-person visits. Medical consultations, follow-up appointments, self-management advice, rehabilitation, and medication management are just a few of the therapeutic services that are delivered *via* secure video and voice connections [4]. People can use this technology to take blood pressure medication, renew prescriptions, and remember appointments. Patients may also send physicians an email describing their symptoms, undergo a series of self-tests, and enroll in step-by-step training programs customized to their illness. Electronic health technology simplifies chronic illness management in all circumstances by putting care monitoring applications and cellphones in the hands of patients. In the event of an emergency, a personal health report will immediately offer vital information to emergency responders, such as diagnoses, medications, drug preferences, and the doctor's contact information. The technology aids clients in organising their medical records in one secure area [5].

The work's goal is to examine current trends and difficulties in the adoption of telemedicine in India. The chapter has been organized into the following sections:

a. The first section looks into the history of telemedicine both in a global as well as in an Indian context.
b. Next, the types and applications of telemedicine are discussed.
c. The legal issues associated with the practice and implementation of telemedicine are put forth.
d. The integration of IT into telemedicine is then showcased followed by a case study.

CHAPTER 7

IoT and Cloud Convergence in Healthcare: An Exploration Analysis

Moushita Patnaik[1] and **Sushruta Mishra**[1,*]

[1] *School of Computer Engineering, KIIT Deemed to be University, Bhubaneswar, Odisha, India*

Abstract: IoT and cloud are the fastest growing technologies today. The convergence of IoT and cloud opens up various new horizons. In the last few years, this convergence of IoT and cloud architecture has dominated not only the research field but also the business sector. The compatibility of these two entirely versatile ideas is their ability to manage the app, user interfaces, and the data stream simultaneously, especially in a high-performance support structure. But along with the advantages comes some disadvantages as well. The major concerns in the IoT - cloud convergence are privacy and security. Therefore, confidentiality must be maintained at all costs. The chapter discusses some prime benefits of IoT and cloud convergence issues and also the challenging concerns of those. This chapter discusses the issues concerned with IoT - cloud convergence and possible solutions to overcome those issues. Later privacy issues of IoT are presented. Then, a case study denoting a pathology tracking model using big data analytics is presented in detail.

Keywords: Big data, Cloud, Extreme Learning Machine, Healthcare, Internet of Things (IoT), Voice Pathology.

INTRODUCTION

It is a widely accepted fact that healing happens faster in the comforts of home. Hospital environments can be very stressful for patients, especially senior citizens and children. Smart healthcare aims at keeping hospital interactions as minimal as possible by making the diagnosis and treatment procedure faster [1]. The world population keeps rising every minute, and so does the number of people who face a health issue. Unfortunately, our healthcare system does not have as many doctors to attend to every patient individually. Smart healthcare helps optimize this doctor-patient ratio such that all patients can get the attention they require. It prioritizes fatal diseases over non-critical ones. Smart healthcare ensures that all

* **Corresponding author Sushruta Mishra:** School of Computer Engineering, Kalinga Institute of Industrial Technology, Deemed to be University, Bhubaneswar, Odisha, India; E-mail: sushruta.mishrafcs@kiit.ac.in

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the available resources at a given point in time are used to their maximum potential.

SOME OF THE LATEST TECHNOLOGIES IN IMPLEMENTATION ARE

Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)

This technology harnesses the neural mechanism of the bacteria and identifies the DNA strands which are infected. It then cuts out those infected strands. It helps to cure the disease from the root [2]. This is the most advanced smart healthcare technology yet.

- **Telehealth**
  This technology helps patients to derive healthcare advice through their digital devices. By 2025, the global telehealth market is expected to be worth $113.1 billion.
- **Virtual Reality**
  Even though virtual reality has been in the market for a long time now, its applications in healthcare are only beginning. Virtual reality would be helpful in diagnosis, treatment plans, and preparation for the procedure.
- **Precision Medicine**
  Precision medicine prevents the painful procedure of surgery if medicine can cure the disease. These medicines directly attack the tumor or the virus and weaken them thus curing the disease.
- **Artificial Organs**
  Getting an organ donor is almost impossible. In a few years, that won't be a problem at all. Scientists have been able to design synthetic organs, blood vessels, *etc.* using 3D printers, that grow inside the body and replace the originally faulty ones. The 3D printers help create both long-lasting and soluble items. This makes surviving an organ failure easier, if not confirmed.
- **Wireless Brain Sensors**
  Scientists have been able to create an implant that can read brain data and can dissolve when it's no longer needed. This makes the reading much more accurate while allowing the patient to be comfortable during the process.
- **Robotic Surgery**
  Robotic surgery is still in research. Though it is not completely trustworthy yet, in a few years it will be ready to provide service whenever needed. Enabling robotic surgery will hugely help in attending to emergency surgeries when a doctor is unavailable.

- **Smart Inhalers**
  It tracks the daily inhaler usage of asthma patients and alerts them about their current health condition so that they contact a doctor accordingly.

These are only some of the latest works that are in progress at this moment. There will be many more inventions to look forward to in the future. The one major issue with these technologies is tons of data and their security. A huge amount of data is generated every day and this number will only keep increasing through the years. Managing all the data and keeping the data secure is going to be a major problem for IoT-cloud convergence. A huge amount of data will require large memory space for storage and processing. This memory space must be safe from all sorts of external and internal attacks like hacking attempts, untrustworthy employees, weak software security architecture, *etc.* This review elaborates on these issues and what strategies can be applied to tackle these. The case study at the end of this review highlights how the IoT cloud convergence can be utilized along with keeping the data secure.

CONCEPT OF IOT

IoT is a network of physical objects, pieces of equipment, devices, automobiles, buildings, and other components incorporated into electronics, software circuits, transmitters, and network connectivity that enables data collection and trade is also known as the Internet of Things. In other words, IoT enables items to be remotely detected and controlled using current network frames. In multiple instances, it has been said that IoT is already here. It is not the future, but the present. IoT has quickly risen as a method of implementing cutting-edge technologies for various industries, even for those whose focus does not lie within the areas of technologies, like, media and communications, health sectors, *etc* [3]. Today, almost all industries are working on the deployment of IoT technologies in some way or the other. But, IoT is not something tangible. We won't see it as it grows. It is how more and more devices are being connected. It is a way devices can communicate with each other faster. Thus, IoT is something we will experience. More connectivity, faster communication, and access to more data are all indicators of IoT [4].

Feasible Applications of Iot

IoT being the most demanded technology of today finds implementation in all fields of the industry, as shown in Fig. (**1**).

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G. Madhu

Dr.G.Madhu is a professor in the Department of Information Technology, VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad-90, India. His research interests are in computer vision, machine learning, and deep learning, which include the fundamentals of algorithms and mathematical modeling.

Sandeep Kautish

Dr. Sandeep Kautish is working as Professor and Dean-Academics at LBEF Campus, Kathmandu, Nepal, in academic collaboration with Asia Pacific University of Technology & Innovation Malaysia. His research interests are in computational intelligence in healthcare, business intelligence, machine learning, the Internet of Things, and intelligent systems in social networks.

A. Govardhan

Dr.A.Govardhan is presently a Professor of Computer Science & Engineering and Rector, Jawaharlal Nehru Technological University, Hyderabad (JNTUH), India. He is the recipient of the Best Senior Scientist Award (2018), Dewang Mehta Academic Leadership Award (2017), Dr. Sarvepalli Radhakrishnan National Award, A.P. State Government Best Teacher Award (2012), Pride of Asia International Award, Best Principal, Bharat Seva Ratna Puraskar, CSI Chapter Patron Award, and Bharat Jyoti Award. His research interests are in areas including Data Warehousing & Mining, Information Retrieval Systems, Database Management Systems, Distributed Databases, Software Engineering, Object-Oriented Analysis & Design, and Software Testing Methodologies.

Mathura Prasad Thapliyal

Dr. Mathura Prasad Thapliyal is a Professor in the Department of Computer Science Engineering, School of Engineering and Technology, HNB Garhwal University (A Central University), Srinagar (Garhwal), Uttaranchal, India. His areas of interest are Human-Computer Interaction, Mobile-HCI, Software Engineering, and Data Mining.

Avinash Sharma

Dr. Avinash Sharma, presently Professor, Maharishi Markandeshwar Engineering College, Mullana, Ambala (Haryana), India. His research interests are in software engineering, machine learning, big data, cloud computing, and IoT.