MOBILE COMPUTING SOLUTIONS FOR HEALTHCARE SYSTEMS

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Bentham Books

Mobile Computing Solutions for Healthcare Systems

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FOREWORD 1

Over the last decade, technological revolution has translated health care systems from its conventional form to the present computer / internet / mobile phone based formats. This paradigm shift has led to several advancements and challenges as well, which need scholarly deliberations. I am immensely pleased to find that this book provides such a platform. This book offers a comprehensive coverage of the wide spectrum of computing solutions available for mobile healthcare systems. It focuses on recent developments such as Artificial Intelligence, Machine Learning Methods, Medical Image Processing, Network Security and Antenna Design techniques, which may be integrated to build promising and secure m-Healthcare systems. Chapters on Smart Wearable Sensors and IoT based solutions for general remote health monitoring as well as their specific application during COVID pandemic are truly contemporary. I congratulate the editors for providing a platform for several researchers to showcase their research findings and achievements in the field of m-Healthcare. I am sure that this book will provide several insights and directions for further research in the area.

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FOREWORD 2

The book presents the latest developments on integrating Artificial Intelligence and Machine Learning methods, medical image processing, advanced network security, and advanced antenna design techniques to bring Mobile Healthcare (M-Health) to new advanced, promising and secure M-Healthcare systems. The book aims to bring together scientists and practitioners from different professional fields to address several kinds of research and achievements in M-Healthcare, based on intelligent IoT and Machine Learning systems for personalized intelligent M-Healthcare and remote monitoring applications. The book will certainly be of special interest to a wide professional audience and it will give precious insights on how to effectively fight diseases with the newest technologies.

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PREFACE

Mobile Health (M-Health) integrates the Internet of Things, mobile computing, medical image processing, medical sensor, and communications technology for mobile healthcare applications. Wireless Body Area Networks (WBANs) of intelligent sensors represent an emerging technology for system integration with great potential for unobtrusive ambulatory health monitoring during extended periods. However, system designers will have to resolve several issues, such as severe limitations of sensor weight and size necessary to improve user compliance, sensor resource constraints, intermittent availability of uplink connectivity, and reliability of transmission, security, and interoperability of different platforms. In addition, there are many challenges like Frequency Band Selection, Antenna Design, Channel Modelling, Energy-efficient hardware, Real-time connectivity over heterogeneous networks Security and Privacy, and others. With the WBAN placed on the patient body in rural areas and the mobile computing devices having the intelligence to acquire and process the data immediately, some of the issues like security and privacy are overcome. More intelligent processing is made available in handheld devices by building more facilities in the device software. This book focuses on recent developments in integrating AI, machine learning methods, medical image processing, advanced network security, and advanced antenna design techniques to bring M-Healthcare systems, leading to a new, promising, and secure M-Healthcare system. This book aims to bring together researchers and practitioners to address several types of research and achievements in the field of M-Healthcare-based intelligent IoT and Machine Learning based systems for personalized intelligent M-Healthcare and remote monitoring applications.

The book is organized into eleven chapters. A brief description of each of the chapters is as follows:

Chapter 1 identifies the existing challenges in the management of channel estimation methods for high-mobility 5G- OFDM systems for 5G. The chapter sets the scene for discussions presented by various authors. In particular, the chapter presented a new channel estimation method for high-mobility 5G- OFDM systems for 5G. Furthermore, the chapter proposed a scheme that is feasible for many current wireless OFDM communication systems.

Chapter 2 presents a novel short-term prediction method for COVID-19. The authors examine the understanding of some challenges and inaccurate predictions of the natural progression of COVID-19. The overall aim of the chapter is to propose a mobile health (M-Health) App and help the user to know the status of the pandemic state and act accordingly.

Chapter 3 presents intrusion detection in IoT-based health monitoring systems. The authors of this chapter implemented and compared the various algorithms on the BoT-IoT dataset and their performance measures.

Chapter 4 presents an analysis of issues and concerns in machine learning methods for intelligent healthcare. The authors provide an outline of the requesting circumstances, conduit, and methods of sharp well-being. A logical conduit of information handling is obliged for regular intelligent well-being, information securing, records preparing, insights dispersal, data security and privateness, and systems administration and processing advancements.

Chapter 5 presents the multi-factor authentication protocol based on electrocardiography signals for a mobile cloud computing environment. This chapter has addressed a proposal and a partial evaluation of a multi-modal protocol that uses three factors (password, IMSI, and biometric signals based on electrocardiograms) to provide mutual authentication to users and CSP.

Chapter 6 reviews the recent trends in the internet of things, challenges, and opportunities. The authors systematically review the analysis of IoT protection and privacy problems, current security strategies, and a list of open topics for potential study.

Chapter 7 discusses the robust medical image watermarking techniques for secure medical data transmission in the mobile healthcare system. Two Robust medical image watermarking techniques are discussed. In the first method, an intelligent-based robust medical image watermarking technique is considered using a genetic algorithm. In the second method, visual meaningful image encryption is discussed to overcome the visual attack.

Chapter 8 presents the smartphone-based real-time monitoring and forecasting of drinking water quality using LSTM and GRU in the IoT Environment. The authors show that analysis made using GRU is much faster than LSTM, whereas the prediction of LSTM is slightly more accurate than GRU. The proposed system produces accurate results and can be implemented in schools and other drinking water resources.

Chapter 9 presents the IoT-enabled crowd monitoring and control to avoid covid disease spread using CrowdNet and YOLO. The authors proposed two modules; a deep CNN CrowdNet people counting algorithm to detect the distance between humans in highly dense crowds and an IoT platform for sending information to the authorities whenever there is a violation. Image processing is carried out in two parts: extraction of frames from real-time videos using YOLO CV, and the second one is the processing of the frame to detect the number of people present in the crowd.

Chapter 10 presents a game-based neurorehabilitation technology to augment the motor activity of hemiparesis patients. The authors of this chapter proposed a method that involves the design of neurorehabilitation technology by developing game-based interventions to improve the motor activities of hemiparesis patients.

Chapter 11 proposes smart wearable sensor design techniques for mobile healthcare solutions. The authors of this chapter discuss the technological developments that have led to the clinical utility of smart wearable body sensors. The authors have highlighted the points in how smart wearable sensors can enhance the physician-patient relationship, promote remote monitoring techniques, and impact healthcare management and spending.

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CHAPTER 1

An SDN Based WBAN using Congestion Control Routing Algorithm with Energy Efficiency

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Abstract: The use of a Software-Defined Network (SDN) approach improves the control and management processes of the complex structured wireless sensor network. Also, it provides higher flexibility and a dynamic network structure. SDN is introduced to efficiently and opportunistically use the limited spectrum to minimize the spectrum scarcity issues. The LEACH protocol is self-organizing and is characterized as an adaptive clustering protocol that randomly distributes energy load among nodes. By using cluster heads and data aggregation, excessive energy consumption is avoided. SDN is often placed in an open environment and is susceptible to various attacks. The routing is based on multihop's flawless hauling range data transmission between the base station and cluster heads.The advantage of LEACH is that each node has the same probability of being a cluster head, which makes the energy efficiency of each node relatively balanced. Massive multiple-input multiple outputs (MIMO) play a polar role within the fifth generation (5G) wireless networks. However, its performance heavily depends on correct synchronization. Although timing offset (TO) can be avoided by applying orthogonal frequency division multiplexing (OFDM) with an adequate length of cyclic prefix (CP), carrier frequency offset (CFO) is still a challenging issue. Especially in the uplink of multiuser massive MIMO systems, CFO compensation can impose a substantial amount of computational complexity on the base station (BS) due to many BS antennas. However, to the best of our knowledge, no study looks into the joint estimation of CFOs and wireless channels in orthogonal frequency division multiplexing (OFDM) based massive MIMO systems. In this project, we propose a low-complexity CFO compensation technique to resolve this problem. In our paper, to traumatize this issue, we tend to propose a low-complexity frequency synchronization technique with high accuracy for the transmission of multiuser orthogonal-frequency-division multiplexing-based large MIMO systems. First, we propose a carrier frequency offset (CFO) estimation whose process complexity will increase linearly concerning the quantity of base station (BS) antennas. We then propose a joint CFO compensation technique that is performed when combining the received signals at the BS antennas. As a result, its machine complexity exceeds the number of BS antennas. As a third contribution, the impact of the joint CFO estimation error is studied, and it is tested that by applying our planned joint CFO compensation technique, the joint CFO

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estimation error causes a continuing section shift solely. We tend to propose an algorithm to expeditiously calculate and take away the estimation error. Our simulation results testify to the effectiveness of our planned synchronization technique. As it is incontestable, our planned synchronization technique results in a bit of error rate performance that is the one for an asynchronous system. This leads to a considerable saving in the computational cost of the receiver. Numerical results are presented to verify the performance of our proposed joint CFO compensation technique and to investigate its computational complexity.

Keywords: Congestion avoidance, Energy-efficiency, Enhanced multi-objective spider monkey optimization, Remote health monitoring, Software-defined network, Specific, Temperature-aware routing, The absorption rate, Wireless body area network.

INTRODUCTION

Driven by the fast step-up of the wireless capability necessities obligatory by advanced multimedia system applications (*e.g.*, ultrahigh-definition video, videogame, *etc*.), and because of the dramatically increasing demand for user access needed for the Internet of Things (IoT), the fifth-generation (5G) networks face challenges in terms of supporting giant-scale heterogeneous information traffic. 5G-OFDM, which has been recently projected for the third-generation partnership project involving long-term evolution advanced (3GPP-LTE-A), constitutes a promising technology for addressing the said challenges in 5G networks by accommodating many users among similar orthogonal resource blocks. By doing this, therefore, important information measure potency improvement is often earned over standard orthogonal multiple-access (OMA) techniques. These various actual analyzers dedicate substantial research contributions to the current field. In this context, we offer a comprehensive summary of state-of-the-art power domain multiplexing-aided 5G-OFDM, with a focus on the theoretical 5G-OFDM principles, multiple-antenna-aided 5G-OFDM design, on the interaction between 5G-OFDM and cooperative transmission, on the resource management of 5G- OFDM, the beingness of 5G-OFDM with alternative rising potential 5G techniques and the comparison with alternative 5G-OFDM variants. We highlight the main advantages of power-domain multiplexing 5G-OFDM compared to alternative existing OFDM techniques. We summarize the challenges of existing research contributions of 5G-OFDM and supply potential solutions. Finally, we provide some design guidelines for 5G-OFDM systems and determine promising analysis opportunities for the long run.

Multiuser Detection

We will solely support K users if we tend to use orthogonal K-chips. However, we will have more users once non-orthogonal m -sequences are victimized within the spirit of 5G-OFDM. Multiple-access interference (MAI) limits the capability and performance of CDMA systems. Whereas the MAI caused by one officious user is tiny, the system becomes interference restricted primarily because the variety of interferers or their power will increase. MUD exploiting the information of each the spreading code associated temporal order (and probably amplitude and phase) information of multiple users has been thought to be an efficient strategy of raising the system capability. Various MUD algorithms, such as the optimal maximum-likelihood sequence estimation, turbo cryptography, matched filter SIC, and parallel interference cancellation (PIC), are designed to scale back the MAI at an inexpensive complexness value. Moreover, some recently developed joint detection techniques for downlink systems are based on single-antenna interference cancellation (SAIC) receivers. This technique depends on either maximum-likelihood detection or pre-detection processing, instead of IC techniques. This development is attributed to the fact that joint detection has also been developed for asynchronous networks [1]. As an additional advance, the proposed SAIC technique has had successful field trial results in the GSM era to suppress the downlink inter-cell interference.

Interference Cancellation

The multiuser IC techniques may be divided into two main classes, particularly pre-interference cancelation (pre-IC) and post-interference cancellation (post-IC). More specifically, pre-IC techniques are utilized at the facet side by suppressing the interference by pre-coding approaches like the famous dirty paper coding (DPC) upon exploiting the knowledge of the channel state information (CSI) at the transmitter. By contrast, the post-IC techniques are usually used on the receiver side to cancel the interference. The post-IC approach can be further divided into two categories, which are parallel and serial. If we carry out accurate power control to ensure that all received signals are similar, PIC outperforms SIC. By contrast, SIC works better when the received powers are different because the strongest user's signal can be detected first. The detected bit is the re-modulate, and its interference is deducted from the received signal. Repeating this action in a sequential order gives us the clean weakest signal. It is worth noting that in addition to the performance *versus* complexity tradeoff, there are also a variety of other tradeoffs between PIC and SIC. There are some recent IC techniques.

CHAPTER 2

COVID-19 - Novel Short Term Prediction Methods

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Abstract: The recent outbreak of Severe Acute Respiratory Syndrome Corona Virus (SARS-CoV-2), also called COVID-19, is a major global health problem due to an increase in mortality and morbidity. The virus disturbs the respirational process of a human being and is highly spreadable. The current distressing COVID-19 pandemic has caused heavy financial crashing and the assets and standards of the highly impacted countries being compromised. Therefore, prediction methods should be devised, supporting the development of recovery strategies. To make accurate predictions, understanding the natural progression of the disease is very important.

The developed novel mathematical models may help the policymakers and government control the infection and protect society from this pandemic infection. Due to the nature of the data, the uncertainty may lead to an error in the estimation. In this scenario, the uncertainty arises due to the dynamic rate of change based on time in the infectious count because of the different stages of lockdowns, population density, social distancing, and many other reasons concerning demography. The period between exposure to the virus and the first symptom of infection is large compared to other viruses. It is mandatory to follow the infected persons.

The exposure needs to be controlled to prevent the spreading in the long term, and the infected people must be in isolation for the above-mentioned period to avoid short-term infections. Officials need to know about the long-term scenario as well as the short-term for policymaking. Many studies are focusing on long-term forecasting using mathematical modelling. For the short-term prediction, this paper proposed two algorithms: 1) to predict next-day count from the past 2 days data irrespective of population size with less error rate and 2) to predict the next M days based on the deviation of the rate of change in previous N-days active cases.

The proposed methods can be adopted by government officials, researchers, and medical professionals by developing a mobile application. So that they can use it

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whenever and wherever necessary. The mobile health (M-Health) App. helps the user to know the status of the pandemic state and act accordingly.

Keywords: COVID-19, Error rate, India, Short term prediction, Spreading rate.

INTRODUCTION

COVID-19 dataset has 3 confirmed cases till Feb 2020 in India. From March 2020, the spreading started, and at the end of June 2020, the total confirmed count reached 400,000. The Indian health care system is handled by both government and private sectors. The people with symptoms are approaching both types of hospitals. They have to plan for infrastructure, manpower, and medical resources. The major focus is to be on rapid testing, diagnosis, availability of trained respiratory therapists, Intensive Care Unit staff, beds, test kits, *etc.* Planning is needed for rationing healthcare resources, which is inevitable for the assurance of consistent allocation. To provide full-fledged medical care with a 1.3 billion population and scarce resources, short-term planning is necessary, along with long-term forecasting. Even developed countries with abundant wealth and health care resources cannot manage the pandemic consequences and must evaluate how the available resources can be utilized rationally, reasonably, and effectively.

Many researchers predicted the count and flattened curve based on the SIR (Susceptible, Infected and Recovered) model, which was useful for making many decisions and preventive measures [1 - 4]. Stochastic and deterministic models can help find the infected size with dynamics over time. The Kermack-McKendrick model is governed by SIR and SEIR (Susceptible, Exposed, Infected, and Recovered) models, and it employs the infection age and structured assumption from 1927 [5]. If an exposed individual gets attached to the pathogen, he may become infected. An individual who is exposed to the pathogen through contact can also act as a carrier. The latent period is defined as the time for the infected person (host) to act as a carrier who can transmit pathogens to other people *via* contact. The incubation period is a period between being exposed to the pathogen and the onset of symptoms of the disease. It can also be defined as the time required for the pathogen to multiply itself to a level in the host to produce symptoms or laboratory evidence. The other features are incidence and prevalence. Incidence is defined as the number of individuals who were infected during a specified interval of time. Sometimes this number can also be divided by the total population. The prevalence is the number of people who have the disease at a specific time. This can also be divided by the total population [6, 7]. SIR and SEIR are standard epidemic models which predict the average number of cases or deaths during the outbreak [8, 9].

The expected number of secondary cases produced by a single infected case in a susceptible population is known as the reproduction number, which is related to daily impact. Many researchers studied this reproduction number since it varies based on country population size, lockdown status, and other parameters [10, 11]. For comparing the predicted values of existing studies, the actual values are taken from www.worldometers.info [12]. Kotwal *et al.* surveyed the COVID-19 studies and concluded a strong relationship between short-term predictions and uncertainty in long-term prediction [13].

The cause for uncertainty is the varying rate of change in cases. Nathaniel S. Barlow and Steven J. Weinstein found the advantage in deriving the analytic nature of the asymptotic approximation. They suggested that the model parameters were extracted through least squares or similar methods without the requirement for an embedded numerical scheme [14]. Another author focused on undetected persons and various infectious cases in hospitals. They analyzed china's COVID-19 data. The proposed model predicted the cases. The differences between the model predicted and the original were very less. This analysis gave an opinion to the policymakers [15]. Duccio Fanelli and Francesco Piazza applied nonlinear fitting and predicted the flattened curve for Italy with the detail that the peak in Italy would be around Mar 21st, 2020 and active count about 26000 (not including recovered and dead). Death counts at the end of the epidemics would be about 18,000 [16]. But 21-Mar, 2020 was not the peak (Apr 20th, 2020 was the peak day), and the infected count on that day was 53,528. Still (19th June 2020), it is not the end of the pandemic, and the death count is 34,514. Another study discussed that the isolation of the affected persons influences the spread of COVID-19. They applied numerical simulation to estimate the end time of the outbreaks [17]. Maleki *et al.* applied time series analysis and showed that the predicted cumulative world infected count and cured count were closer to the actual count [18].

Long short-term memory and deep learning were applied to predict the future cases of COVID-19 in Canada and other countries. The prediction on 28-Apr, 2020 was around 22,000 confirmed cases [19]. But the actual count on that day was 50,026. For the short duration, the RMSE value of 51.46 is less, but if the April month prediction is checked against the actual count, then for the LSTM model, the error will be more. From these studies and analysis, is it possible to predict the next day or week count that is closer to the actual? To solve this, the paper proposed two algorithms to predict the next day count from the two previous days, and predict the next M days count from the Previous N-days. The purpose of the short-term prediction is to plan the immediate requirement of beds, ventilators, test equipment, test plan, social distancing control, *etc.*

CHAPTER 3

Intrusion Detection in IoT Based Health Monitoring Systems

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Abstract: The internet of things (IoT) is making its impact in every possible field like agriculture, healthcare, automobile, traffic monitoring, and many others. Especially in the field of healthcare, IoT has numerous benefits. It has introduced the concept of remote monitoring of patients with the help of IoT devices. These devices are turning out to be a game-changer and are helping healthcare professionals monitor patients and suggest recommendations with the help of data obtained from connected devices or sensors. Telemedicine, which helped provide remote medical services to patients, has gained importance, especially during this COVID-19 pandemic. It has helped the patients have online consultations with the doctor during the lockdown period, decreasing the need for unwanted hospital visits during pandemic times. Since these IoT-related networks are used daily, from health monitoring wearables to smart home systems, they must be protected against security threats. Thus, intrusion detection System is significant in identifying intrusions over an IoT network. intrusion detection Systems can be deployed by utilizing Machine Learning, and deep learning approaches. This paper aims to implement various algorithms on the BoT-IoT dataset. Moreover, their performance measures are compared and analyzed.

Keywords: BoT-IoT dataset, Intrusion Detection, Machine Learning algorithms.

INTRODUCTION

IoT is now playing a vital role in smartly changing everyone's life. The increasing penetration of IoT in our lives lets us save money and a lot of human work and manages time. It helps in collecting data and provides optimal solutions too. As every possible device is connected to the internet now, it is known that there will be an enormous amount of data that gets generated from those devices, which will

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help provide insights. Since most of these IoT devices are used in households, healthcare, agriculture, industries, and even as wearables, it is a must that each of these devices must be protected from security threats of varying nature. Especially IoT has numerous benefits in the field of healthcare. It helps in providing an opportunity for healthcare professionals to continuously monitor the patients with the assistance of IoT devices. The details obtained from the devices helped provide the patients with valuable insights. Various diagnoses can also be drawn from the insights analyzed from the IoT-generated data. COVID-19 has also made a massive acceleration in the usage of telemedicine, which helps in providing remote medical services to patients during the lockdown. On the other hand, telemedicine helps in regular monitoring of the health conditions of the patients with the help of IoT devices, such as wearables, that help in tracking the heart rate, sleeping patterns, and other health-related parameters. It is believed that doctors can also know the history of the patients with the assistance of data obtained from the devices.

As advantageous as these IoT devices are, they are also vulnerable to security threats. Some major security attacks include the Wannacry ransomware attack in May 2017, where the hackers encrypted the users' data who used older and unsupported versions of Microsoft Windows OS and demanded ransomware from the users. Another data breach that targeted the credit card credentials of 40 million Target customers occurred in 2013. The attackers performed the data breach through an HVAC and refrigeration company where an e-mail containing malware was sent to that company which in turn provided a chance to steal the credit card credentials. Around December 2013 and January 2014, a researcher from Proofpoint, while analyzing e-mail threats, observed that over 750,000 malicious e-mails were found to have been received from IoT devices, which include televisions and at least one refrigerator. Since these IoT-related systems are used daily, from health monitoring wearables to smart home systems, they must be protected against security threats. Thus, an Intrusion Detection System (IDS) is a significant solution that helps in identifying intrusions over an IoT network. IDS helps in the classification and categorization of intrusions. Machine Learning and Deep Learning techniques are used to deploy Intrusion Detection systems. This paper aims to implement various algorithms on the BoT-IoT dataset, and the performance measures of the algorithms were analyzed and compared.

RELATED WORKS

Intrusion Detection is a method where a model or system is built to detect any kind of suspicious activity. It helps in alerting the user when such types of activities are detected. There are various kinds of Intrusion Detection systems. Among those, two main types are:

Host-Based Intrusion Detection System (HIDS)

These systems keep track of the independent devices over a network. The system focuses only on the packets that are received and sent from that device. The system takes a snapshot of the files and compares it with the previous snapshot of the files, and if there is any modification in the system files, then the HIDS sends an alert to the administrator.

Network Intrusion Detection System (NIDS)

NIDS are employed over the network to find any kind of breaches in the security of the network. This system is generally placed at the points where the network traffic is vulnerable to attacks. NIDS is likely to be placed in the entire subnet, and it observes the incoming network traffic and compares it with the library of known attacks. If any security breach is identified, the administrator is notified with an alert.

Random Forest is a machine learning algorithm that builds many Decision Trees and combines all the decision trees to make the prediction much more accurate. In a study [1], the classification of the attacks is performed by training the algorithm with the available sample data. The class selected the most is chosen as the final output. It was also found that Random Forest Network was good at multi-class classification, and its accuracy was also found to be high. The model proposed by Nathan Shone *et al.* [2] uses a deep learning algorithm along with the speed and accuracy of Random Forest. Mohamed *et al.* [3] use Random Forest as the classifier for intrusion detection and Neural Network to categorize the intrusions. Random Forest is considered an ensemble classifier that produces low classification error [4] and performs effective classification compared to the other classification algorithms. An algorithm that is a supervised one and also used for classification and for detecting outliers is the Support Vector Machine (SVM). SVM is applied on a labelled KDD 1999 Intrusion Detection dataset and worked very effectively on that labelled dataset [5]. Various SVM techniques like Linear SVM, Quadratic SVM, Fine Gaussian SVM, and Medium Gaussian SVM are used over the NSL-KDD dataset. Fine Gaussian SVM is concluded to provide the best accuracy of 98.7% and a minimum error of 1.3% [6]. A multi-class SVM was used to build an IDS, and it was implemented by Vijayanand *et al.* [7] on the Advanced Metering Infrastructure of Smart Grid to detect security threats. It was found that the implemented IDS correctly detected the attack. Logistic Regression (LR) is utilized to predict the outcome based on the independent variables. Logistic Regression is also used as a classifier in Intrusion Detection systems. IDS

CHAPTER 4

Machine Learning Methods For Intelligent Health Care

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Abstract: The headway of man-made reasoning techniques overlays the methods toward shrewd medical services by growing new ideas, for example, Machine learning. This part presents an outline of Machine learning procedures applied to brilliant medical services. AI procedures are regularly applied to brilliant well-being to empower Artificial knowledge based on a current innovative improvement to medical care. Moreover, the section likewise presents difficulties and openings in Machine adapting, especially in the medical services space and near examination of different AI techniques.

Keywords: Artificial Intelligence, Crowdsource, Machine learning, Radiotherapy.

INTRODUCTION

Progressive technologies have created an effect on many components of our day-to-day life. Smart healthcare is defined *via* the technology that results in higher diagnostic gear, higher remedies for sufferers, and gadgets that improve the fine of life for everybody and everybody. The main idea of clever fitness includes electronic Health and Mobile Health offerings, digital file control, clever home offerings, and shrewd and related scientific devices.

Electronic Health (eHealth) uses information and communication technology (ICT) to maintain and access the medical health records of people. Examples encompass treating patients, undertaking studies, instructing the fitness team of workers, tracking diseases, and tracking public health. eHealth can benefit the whole community with the aid of improving access to care and satisfaction of care

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and by making the fitness area greater green [1]. This includes facts and information sharing between sufferers and health provider companies, hospitals, fitness experts, and the fitness data community; digital health information; telemedicine services; portable affected person-monitoring devices, running room scheduling software, robotized surgery and blue-sky research at the virtual physiological human."

Mobile health has been described as "an element of eHealth". Due to this fact, there is no traditional description of Mobile Health. According to World Health Organization, it can be defined as "clinical and public health exercise supported through mobile gadgets, such as cellular phones, affected person tracking devices, personal digital assistants (PDAs), and different wi-fi devices [2]." Mobile Health moreover consists of complicated capabilities and mobile data standards like GPRS, 3G and4G systems, GPS and Bluetoothgeneration.

Machine Learning (ML) is the analysis of PC-based calculations that improve precisely through experience. It is far more noticeable as a subset of AI. ML calculations develop a model dependent on example data, alluded to as "Preparing records", to settle on forecasts or decisions without being expressly modified to do as such [3]. AI calculations are used in an immense style of projects, along with electronic mail separating and PC vision, in which it is far troublesome or unworkable to widen regular calculations to play out the needed commitments.

A subset of ML is painstakingly identified with computational insights, which has practical experience in utilizing PC frameworks; yet at this point, not all frameworks acquiring information is measurable learning [4]. The numerical streamlining includes techniques, hypotheses, and sharpness areas in the field of ML. Information mining is a connected control, that has some expertise in exploratory records examination through solo acquiring information. In its utility across business issues, Machine Learning is known as prescient investigation [5].

Without being explicitly configured to do so, ML includes PCs running over how they can perform obligations. It incorporates PC frame works gaining from in formation outfitted all together that they play out specific obligations. For simple commitments doled out to PC frameworks, it is practical to program calculations advising the device on how to execute all means needed to determine the current issue; at the PC's part, no acquiring information is needed [6]. For further developed things, it could be trying for a human to physically make the wished calculations. M|L model can be implemented with the efficient algorithm used for training the machine to get the required and satisfied output.

When no top-notch set of rules is available, the order of gadgets considering employs several ways to teach PCs to do tasks. In cases wherein full-size quantities of limit arrangements exist, one strategy is to mark a portion of the ideal answers as authentic.This may then be utilized to prepare insights for the PC to improve its arrangement of rules to decide the right arrangements. For example, to show a device for the assignment of virtual man or lady notoriety, the MNIST dataset of manually written digits has consistently been utilized [7].

APPLICATIONS OF MACHINE LEARNINGIN HEALTH CARE

Medical care is a fundamental industry that offers esteem-based consideration to countless people, even at the equivalent time turning out to be apex deals workers for some countries. These days, the Healthcare business inside the US procures an income of $1.668trillion. The United States of America likewise spends more prominent on medical services steady per capita contrasted with most unique progressed or agricultural countries [8]. Quality is a cost that normally goes with medical services and guarantees a great deal. Today, medical care-trained professionals and partners around the planet are searching for reformist techniques to convey this guarantee. Innovation empowered astute medical services is not, at this point, a trip of extravagant, as web-associated clinical contraptions are keeping the well-being framework as far as we might be concerned together from self-destructing beneath the populace trouble.

From assuming a significant part in patient consideration, charging, and clinical realities, the present age allows medical care specialists to increment substitute staffing models, IP capitalization, offer astute medical services, and diminish authoritatively and convey costs. ML in medical care is one such territory that is seeing slow acknowledgement inside the medical services industry [9]. Google evolved a set of rules to get mindful of destructive tumours in mammograms, and specialists in Stanford school utilize the profound learning information to get mindful of skin malignancy. ML is, as of now, helping with various conditions in medical services. ML in medical services assists with breaking down bunches of different insight factors and prompt outcomes, offers ideal danger rankings, specific guide allotment, and has numerous applications [10].

Diagnosis of Diseases

One of the main ML programs in medical care is the ID and investigation of infections and sicknesses that are considered hard to analyze in some cases. This may comprise malignancies that are hard to get sooner or later of the fundamental degrees, to other transmissible disorders [11].

CHAPTER 5

Multi-Factor Authentication Protocol Based on Electrocardiography Signals for a Mobile Cloud Computing Environment

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Abstract: Mobile Cloud Computing (MCC) is a highly complex topic that encompasses several information security issues. The authentication area of the various entities involved has been extensively discussed in recent years and shown a wide range of possibilities. The use of inadequate authentication processes leads to several problems, which range from financial damage to users or providers of Mobile Commerce (M-Commerce) services to the death of patients who depend on Mobile Healthcare (M-Health) services.

The design of reliable authentication processes that minimize such issues involves the use of non-intrusive authentication techniques and continuous authentication of users by MCC service providers. In this sense, biometrics may satisfy such needs in various scenarios.

This research has explored some conceptual bases and presents a continuous authentication protocol for MCC environments. Such a protocol is part of a cyberphysical system (CPS) and is based on the monitoring of physiological information interpreted from users' electrocardiograms (ECG). Machine learning techniques based on the Adaptative Boost (Adaboost) and Random Undersampling Boost (RUSBoost) were used for the classification of the cardiac cycles recognized in such ECGs.

The two ML techniques applied to electrocardiography were compared by a random subsampling technique that considers four analysis metrics, namely accuracy, precision, sensitivity, and F1-score. The experimental results showed better performance of RUSBoost regarding accuracy (97.4%), precision (98.7%), sensitivity (96.1%), and F1- score (97.4%).

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Keywords: Authentication, Electrocardiography, Machine Learning, Mobile Cloud Computing.

INTRODUCTION

Mobile Cloud Computing (MCC) has arisen from the combination of the flexibility of mobile computing and the storage and processing capabilities of cloud computing [1]. Most processing and storage of data from mobile devices are transferred to centralized computing platforms located in the cloud, thus enabling such devices of lower computational capacities to run more complex applications and access new resources and services [2], if they are connected to the cloud through the various technologies available (*e.g.,* local area wireless networks (WiFi) and cellular networks (*e.g.,* 3G, 4G, 5G).

Fig. (**1**) shows a typical and simplified architecture of both MCC and the services that can be provided. It displays mobile users with their equipment accessing computing cloud services (Infrastructure as a service - IaaS, Platform as a service - PaaS and Software as a service - SaaS) through conventional wireless Internet access connections [3].

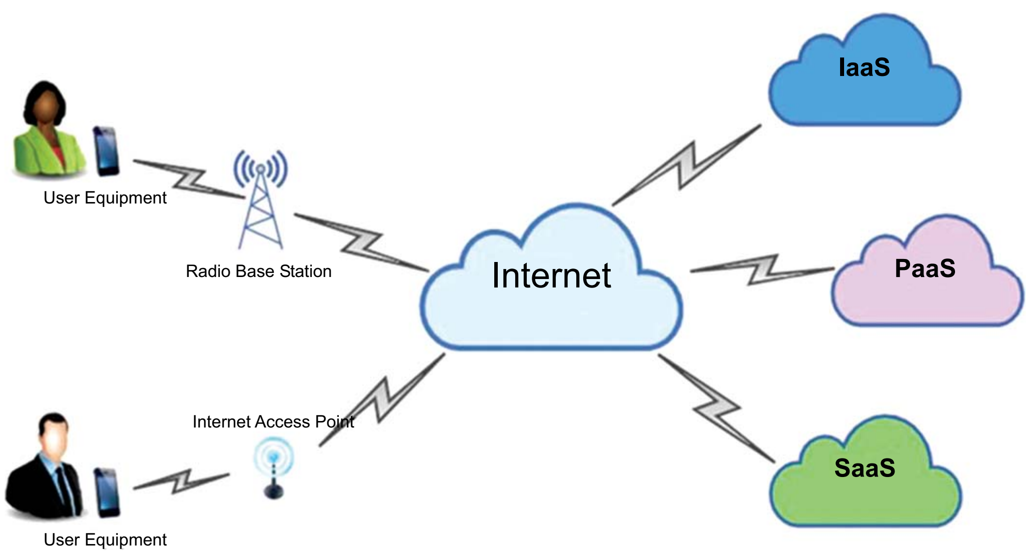

Fig. (1). Typical architecture of MCC services.

Such a style of use of computer environments has evolved in recent years greatly due to the significant expansion of the smartphone market, which has increased the number of mobile computing users and, consequently, required qualitative and quantitative improvements in the infrastructures focused on this segment.

Despite the benefits of cloud mobile computing, new problems have arisen. The area of information security, for example, shows several loopholes that did not exist in other more traditional architectures [4]. Because cloud computing is based on the remote use of information for either its simple storage, or processing, several fundamental pillars of information security (*e.g.,* confidentiality, integrity, availability, and authenticity) have been threatened [5].

Due to the considerable increase in the number of elements between the user interface and the place where the information will be stored and/or processed in the cloud, in comparison to isolated architectures, the authentication of the integral parts of an MCC architecture has drawn the attention of academic and commercial circles [6].

A few studies [7 - 11] analyzed and/or proposed authentication solutions for MCC environments, which indicates the existence of many widely used authentication methods and protocols globally recognized by researchers and even standardized by some regulatory bodies. Among such methods, some biometric techniques have proved interesting alternatives, not only because they depend exclusively on intrinsic human aspects to be authenticated, but also because they enable the continuity of authentication (the user can remain authenticated throughout the session [12] in a transparent or non-intrusive manner), and authentication at an early stage of a session or transaction (*e.g.,* access of user´s equipment to the MCC infrastructure).

Electrocardiography-based biometrics is one such option. Its characteristics are unique, hardly falsified, can be measured, and are exhibited with no individual´s voluntary intervention, or intervention by an individual from whom they are extracted [13 - 15]. Therefore, the method can be used in activities of authentication of individuals by automated information systems.

Although electrocardiography is a good option for authentication, the misinterpretation of data from electrocardiograms (ECGs) can lead to distortions. Machine learning (ML) [16] has shown a flexible and robust alternative for minimizing such a problem since it provides good solutions to complex classification issues and effectiveness and efficiency for authentication.

ML techniques include ensembles (*e.g.,* AdaBoost, Robust Boost, Random Forest), which represent a strategy according to which multiple simple learners are trained and then used in combination [17]. They can provide a better performance, in terms of precision, sensitivity, and accuracy, in comparison to that of the best simple classifier from the set used individually, and in many cases, to that of different and more complex classifiers trained under other strategies [18]. Consequently, they have been used in several tasks involving signal and data

CHAPTER 6

Recent Trends in Mobile Computing in Health Care, Challenges and Opportunities

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Abstract: This paper provides an analysis of IoT protection and privacy problems, as well as current security strategies, as well as a list of open topics for potential study. The most significant inventions are those that vanish. They become indistinguishable from the structure of daily existence when they weave themselves through it. This Internet of Things idea has begun to transform our modern environment, including a common man's daily existence in society, a world in which machines of all shapes and sizes are produced with "smart" capabilities that enable them to connect and interact not only with other devices but also with humans, share data, make autonomous decisions, and perform useful tasks based on predetermined conditions. With its many implementations, the Internet of Things is now a well-known phenomenon across both horizontal and vertical industries.

Keywords: Autonomous, Healthcare, Internet of Things, Smart, Smart IoT.

INTRODUCTION

The environment is rapidly changing from disconnected networks to pervasive Internet-enabled 'things' capable of communicating with one another and producing data that can be analyzed to obtain useful knowledge. The Internet of Things, a massively integrated digital network system, would enhance everyone's existence, increase company growth, boost government performance, and so on. However, from the standpoint of protection and privacy, this modern reality (IoT) created on the Internet poses new problems. Because of the various requirements and networking stacks involved, traditional protection primitives cannot be explicitly extended to IoT technologies. Along with scalability and heterogeneity

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problems, resource-constrained systems like RFIDs and wireless sensor nodes make up a large part of IoT infrastructure. As a result, in such a complex setting, a scalable architecture capable of dealing with protection and privacy concerns is needed. To illustrate how the Internet of Things could impact our everyday lives, consider the following scenario: You walk into the store and get a text message from your refrigerator. Sensors in the dairy aisle warn your grocery cart that you've picked up a milk carton. Your exercise wristband vibrates as you head through the store, taking your vitals and sending the findings to your doctor to change your order. You just step out the door after you've done shopping. When you leave the geophone of the store, your credit card is paid. To avoid collisions, the automobile interacts with other vehicles on the road when you head home. Machine to Machine (M2M) correspondence was the foundation of the Internet of Things (IoT) in its early years. M2M connectivity refers to two computers interacting with each other without the need for human intervention. The networking medium isn't defined, and it may be either wireless or wired. The word “machine-to-machine” (M2M) comes from telephony networks. Different endpoints in these networks required to share details with one another, such as the caller's name. This data was transmitted between the endpoints without the need for a person to start the transmission. M2M is still widely used, especially in the industrial industry, and is sometimes considered a subset of IoT [1-5].

Computing devices embedded in everyday items are connected through the Internet, allowing them to transmit and receive data. Nonetheless, modern IoT network technologies such as e-healthcare and transportation services have expanded this definition during the last decade. The Internet of Things arose from the integration of wireless technology, micro electromechanical systems (MEMS) advances, and digital electronics, resulting in small computers that can detect, calculate, and interact wirelessly. The connection or partnership between humans and machines is becoming increasingly important in the Internet of Things age, as machines get smarter and begin to do more human activities, and in this case, humans [6-10].

The next generation of computing will occur outside of the standard desktop setting. Many of the artifacts that accompany us would be linked in any way under the Internet of Things (IoT) model. This latest task, in which knowledge and communication networks are invisibly integrated in the world around us, would be met by RFID and sensor network technology is shown in Fig. (**1**). As a consequence, massive quantities of data are produced which must be collected, analyzed, and displayed in a smooth, effective, and easily interpretable manner. This model would consist of goods that are distributed in a comparable way to standard commodities. Cloud services will include the virtual architecture for utility computing, which includes reporting, storage, analytics, visualization platforms, and client distribution. Businesses and customers would be able to access services on demand from everywhere thanks to the cost-based model that Cloud infrastructure provides [11-15].

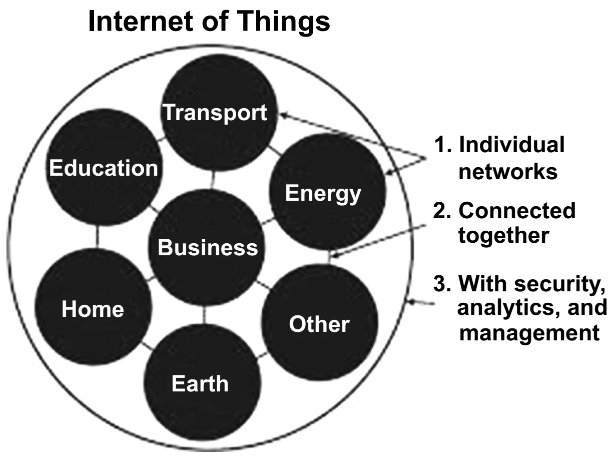

Fig. (1). Various applications in internet of things.

Internet of Things

IoT needs smart integration with current networks and context-aware computing utilizing network tools. The evolution toward universal knowledge and networking networks is already visible, with the growing presence of WiFi and 4G-LTE wireless Internet connectivity. However, in order for the Internet of Things vision to succeed, the computing criterion would need to expand past conventional mobile computing situations involving smart phones and portables, and into integrating ordinary existing devices and embedding information into our world. The Internet of Things requires a common knowledge of the condition of its consumers and their machines, software architectures and ubiquitous communication networks to store and communicate contextual knowledge to where it is important, and analytics tools in the Internet of Things that allow for autonomous and smart actions in order for technology to vanish from the user's consciousness. Smart integration and context-aware computing can be achieved with these three basic foundations in place. A transformative transformation of the modern Internet into a network of integrated objects that not only gathers data from the atmosphere (sensing) and communicates with the real universe (actuation/command/control), but also incorporates established Internet protocols to offer services for data transfer, analytics, software, and communications. IoT has grown out of its infancy and is on the brink of converting the existing static Internet into a truly developed.

CHAPTER 7

Secure Medical Data Transmission In Mobile Health Care System Using Medical Image Watermarking Techniques

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Abstract: Medical information is maintained in a digital format, like scanned images along with patient information. In the mobile health care system, digitized medical information is transmitted to remote specialists for diagnosis purposes. The remote specialists verify the patient medical information using mobile or other devices and suggest the treatment. During medical data transmission, through unsecured media, there is a chance to modify the medical data by the attacker. It leads to the wrong diagnosis and affects the patient's entire life. So there is a need for secure medical data transmission in mobile healthcare to protect medical information from unauthorized users or intruders. The medical image watermarking technique is required to protect medical information in mobile healthcare. To withstand various medical image watermarking attacks, this chapter discusses two different types of robust medical image watermarking techniques in mobile healthcare. First, an intelligent-based medical image watermarking technique is discussed to protect the medical data in a secured manner during the electronic patient information embedding part. After embedding the patient information in the medical image, the generated watermarked medical image looks like an original medical image. So the attacker knows the visual existence of the medical data during its transmission. To avoid this, the second technique, *i.e.,* the visual medical image encryption technique, is discussed. The mobile healthcare system uses the intelligent medical image watermarking technique and visual medical image encryption for the secure transmission of medical information.

Keywords: Genetic algorithm, Image encryption, Medical image watermarking, Singular value decomposition, Visual image encryption.

INTRODUCTION

In the conventional medical system, the patient should be present physically, and the treatment is a very long time process. However, using the recent development

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of Information and Communication Technology (ICT), an effective medical system is provided at a distance. Nowadays, a mobile health care system has been introduced to make the health care system effective, quick, and easy to access. With the prompt advancement in telecommunication and medicine, in the mobile health care system, the medical images are transmitted to the remote specialists along with the Electronic Patient Record (EPR) for diagnosis purposes. On the receiver side, the remote specialist uses this transmitted medical data for diagnosis purposes using mobile or other devices. It makes it easier to access. Due to this easy access, the mobile health care system compromises medical data security. Fig. (**1**) shows the mobile-based robust medical image watermarking technique.

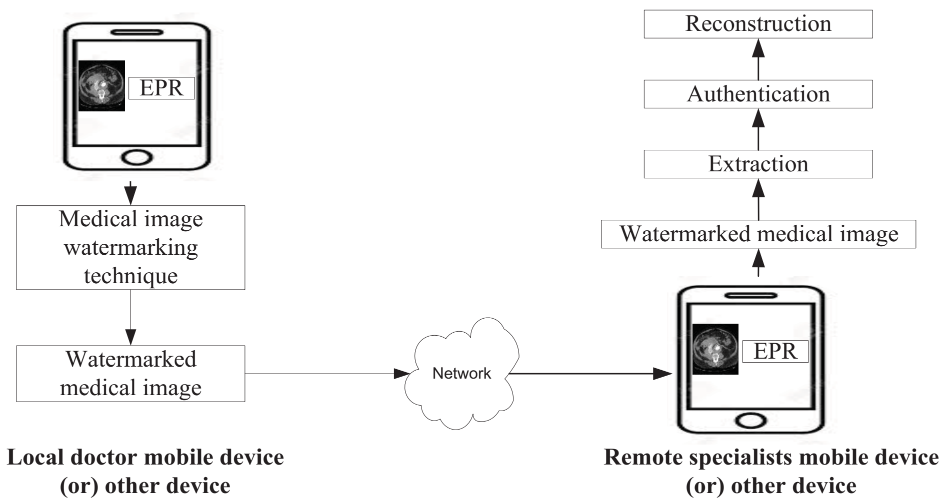

Fig. (1). Medical image watermarking in the mobile healthcare system.

So, one of the main challenging criteria in the mobile health care system is secure medical data transmission in open media. It is achieved by medical image watermarking techniques [1, 2]. In this technique, the electronic patient information is embedded within the medical image. Then the embedded watermarked medical image is transmitted to the remote specialist through mobile [3]. At the remote specialist side, the transmitted watermarked medical image is received and used for the diagnosis.

Image watermarking techniques are divided into different types based on the working domain (Spatial & Transform), Human Visual System characteristics (HVS), fragile- and robust-based [4, 5]. To transmit the medical image in a secured manner against various attacks, a transformed-based robust watermarking technique is required. So this chapter focus on robust medical image watermarking techniques in the mobile health care system.

Singular value decomposition and DWT are used to generate the robust medical image watermarking technique [4]. SHA-512 is used to generate the digital signature for the iris image. In the region of non-interest part, the watermark information (EPR, Digital signature, reference watermark) is embedded. It requires more time for hash value generation. For telemedicine [5], robust dual medical image watermarking is generated. Singular Value Decomposition (SVD) and Discrete Wavelet Transform (DWT) are used to increase the embedding capacity. Multiple watermarking techniques are proposed in the transform domain using DWT, DCT, and SVD [6].

Electronic patient information is embedded in the medical image using Gould and integer wavelet transform to increase security. However, its embedding capacity is low [7]. Therefore, an encryption-based watermarking technique is proposed in telemedicine. A chaotic-based fragile watermarking technique is proposed with a high payload in a cloud environment [8], but it does not withstand against robustness attack. Furthermore, a robust watermarking technique is proposed using spatial and transform domains [9]. Within the singular component, the watermark information is embedded. A spread spectrum-based medical image watermarking technique is also proposed [10].

In all the previous methods, the watermarked medical image is similar to the original medical image. So the attacker visually knows the medical image transmission. To avoid the visual existence, watermarking method image encryption technique is used. The image encryption output is similar to noisy data or modified data. It depicts that some secret information is present in an unreadable format. Therefore, to overcome the drawbacks of the existing methods, this chapter discusses the two types of security techniques for mobile healthcare systems. To increase the robustness of the medical image watermarking technique, the intelligent-based watermarking technique using a genetic algorithm is discussed, and to avoid the visual existence of the medical image watermarking technique, a visually meaningful image encryption technique is discussed.

Performance Measures

To evaluate the performance of the medical image watermarking techniques, the following metrics from Equations **1-5** are considered in this chapter. In all the metrics, the original medical image is referred to as the X, and the watermarked medical image is considered as X' with the pixel position as (u,v) and size as MXN.

CHAPTER 8

Smartphone-Based Real-Time Monitoring and Forecasting of Drinking Water Quality using LSTM and GRU in IoT Environment

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Abstract: Water quality plays an important role in human health. Contamination of drinking water resources causes waterborne diseases like diarrhoea and even some deadly diseases like cancer, kidney problems, *etc.* The mortality rate of waterborne diseases is increasing every day and most school children get affected to a great extent. Real-time monitoring of water quality of drinking water is a tedious process and most of the existing systems are not automated and can work only with human intervention. The proposed system makes use of the Internet of Things (IoT) for measuring water quality parameters and recurrent neural networks for analysing the data. An IoT kit using raspberry pi is developed and connected with a GPS module and proper sensors for measuring pH, temperature, nitrate, turbidity, and dissolved oxygen. The measured water quality data can be sent directly from raspberry pi to the database server or through the mobile application by QR code scanning. Recurrent Neural Network algorithms namely Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) are used for forecasting water quality. Results show that analysis made using GRU is much faster than LSTM, whereas prediction of LSTM is slightly more accurate than GRU. The data is categorized as poor, moderate, or good for drinking and it can be accessed using smartphones through mobile application. In general, the proposed system produces accurate results and can be implemented in schools and other drinking water resources.

Keywords: Gated Recurrent Unit, Internet of Things, Long Short-Term Memory, Recurrent Neural Networks, Water Quality Parameters.

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INTRODUCTION

In most parts of the world,especially in India, groundwater is used for drinking. Around one and half million people of the world population rely upon groundwater for drinking purposes [1]. With an increase in world population, high industrialization, use of excessive fertilizers, reduction in rainfall, *etc.*, the quality of groundwater is deteriorating [2, 3, 4]. Rivers, dams, and ponds are all sources of surface water, meeting the need for drinking water to some extent. Due to the lack of surface water, drinking water is provided to people through transportation. Drinking water either groundwater or surface water results in diseases caused by water-borne agents due to inadequate quality of water.

The water quality is governed by physical and chemical properties of water such as temperature, dissolved oxygen, nitrate content, turbidity, *etc.* Turbidity is a term that checks the concentration of extraneous particles in water. Drinking water with a large quantity of dissolved oxygen is good, and it also makes the water taste better. Groundwater and surface water are contaminated by nitrate due to the excessive use of nitrogen fertilizers, and the consumption of high amounts of nitrate adversely affects health. Excess nitrate consumption can lead to cardiovascular disease, stomach cancer, lung disease, *etc.*

pH of drinking water is a measure of charged particles in drinking water. The pH of good drinking water should lie between 6.5 – 7.5. A low value of pH indicates acidic properties and a higher value of pH indicates alkaline properties. Both too much acidity and alkalinity are not good for human health. Drinking water contaminated with nitrate has severe impacts on human health.

Human body parts that are prone to cancer due to nitrate contamination are the urinary bladder, brain, rectum, kidney, pancreas, breast, ovary, and stomach [5 - 12]. Overconsumption of nitrate by pregnant women may lead to premature births, birth defects of the abdominal wall, low birth weight, gastroschises, *etc.* in newborns [13 - 16].

Several other diseases related to the central nervous system and thyroid have a close association with nitrate ingestion. Several recent studies show that gastrointestinal (GI) illness that occurred in the US is a water-borne disease and has proximity to turbidity of water [17]. Alkaline drinking having higher pH doesn’t cause adverse health effects and even can be used in the treatment of reflux disease [18] whereas, on the other hand, acidic drinking water which has low pH can be a root cause of diseases like diarrhoea, abdominal pain, organ damage, nausea, and vomiting. Acidity in water is mainly due to toxic metals that are mixed with water [19].

E. coli (Escherichia coli) bacteria that live in human or some animal intestines is transmitted to surface water through human faecal material.

Although most *E. coli* are not dangerous, some of them are dangerous enough to cause bloody diarrhoea [20]. There is a link between water temperature and *E. coli* count. The temperature that is suitable for *E. coli* growth is 20°C to 37°C. A very high or very low temperature is not suitable for the growth of *E. coli*.

Generally, water samples are taken and then the water quality parameters are measured using the suitable methodology and then analysed. Such methods are time-consuming and real-time access to such data is not possible. The Internet of Things (IoT) makes it possible to control any physical device through the internet from any part of the world. There are about 22 water quality parameters [21] and it is not possible to measure all physical and chemical properties of drinking water using the internet of things in real-time and it will cost an enormous amount. But it is possible to measure the prominent water quality parameters using sensors and the internet of things [22]. IoT makes use of water quality sensors, Arduino, NodeMCU, Raspberry Pi 2 or 3, *etc.* for measuring water quality parameters. Sensors are usually analog and need an analog to digital converters (ADC) for transmitting the signals for further analysis. Compared to Arduino or NodeMCU, Raspberry pi has the better computational capability. It is possible to transmit the sensors' values from these low computational devices to database servers. Some analysis algorithms need high computation and memory and for such analysis, data can be accessed directly from these database servers.

A recurrent Neural Network (RNN) is a deep learning network that is commonly used for prediction. Major components of a normal neural network are the input layer, out layer, hidden layer, and an activation function. A deep neural network has hidden units making it more accurate. Long Short Term Memory (LSTM) and Gated Recurrent Unit (GRU) are two types of RNN algorithms. With the help of RNN algorithms, it is possible to predict the changes in water quality parameters.

Smartphones have become an essential part of the day to day life. Smartphones with the Android operating system are sold in large numbers around the world and especially in the Indian market. Global Internet usage is on the rise every day. The main reason for the reduction in the cost of internet data is the competition between Internet service providers, which results in declining Internet data prices . There are new technologies introduced in the smartphone market such as the introduction of 5G networks, the introduction of new mobile processors with high computational capability, *etc.* Recent developments in AngularJS, React, Node.js, and Ionic framework make it possible to create cross-platform native mobile and web applications. This saves the time of coding different applications for android,

CHAPTER 9

IoT-Enabled Crowd Monitoring and Control to Avoid Covid Disease Spread Using Crowdnet and YOLO

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Abstract: COVID-19 is an infectious disease that has spread globally, and the best way to slow down transmission is to maintain a safe distance. Due to the COVID-19 spread, social distancing has become very vital. Furthermore, the formation of groups and crowds cannot be left unseen. Even when the necessary regulations have been implemented by governments worldwide, people tend not to follow the rules. We wanted to make it possible for authorities in areas like schools, universities, industries, hospitals, restaurants, *etc.*, to monitor people breaking social distancing rules and take appropriate measures to control the virus from spreading. To monitor and control the crowd, society requires a system that does not put other people's lives at risk. Therefore, it is critical that we stop it from spreading further. Initially, the government imposed a lockdown to control the spread of the virus. Due to the lockdowns, the economy had experienced some negative effects. Due to the economic slowdown, people were allowed to go out and carry on with their regular tasks, leading to crowding in many places, intentionally or unintentionally. The research work aims to make a crowd detection and alert system in public places like hospitals, schools, universities, and other public gathering events. The proposed idea has two modules; a deep CNN CrowdNet people counting algorithm to detect the distance between humans in highly dense crowds and an IoT platform for sending information to the authorities whenever there is a violation. Image processing is carried out in two parts: extraction of frames from real-time videos using YOLO CV, and the second is processing the frame to detect the number of people in the crowd.

The crowd counting algorithm, along with the vaccination, will enforce safety rules in people-gathering places and minimize health risks and spread. The image processing YOLO model mainly targets people not following social distancing norms and standing very close by. The data for the violations are sent online to the IoT platform, where the value is compared to a threshold. The platform aids in sending alerts to the concerned authorities in case of significant violations. Warnings are sent through e-mail or personal messages to the concerned authorities and the location.

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This model prevents the presence of an official to check whom all are violating the rules. There is no need for human intervention and risking their lives; direct messages can be sent through the IoT platform to authorities if there is a crowd formation. Data analytics can help find out the peak hours of crowding and help control the crowd much more efficiently. CrowdNet, a deep CNN algorithm, will estimate the number of humans in a given frame to classify the locations where most people communicate and check whether the safe distance is not reached and the number of times it is not reached. Our system sends the number of people available in the frame at that moment and whether they are maintaining social distancing or not. The Deep CNN algorithm will filter the objects by capturing high-level semantics required to count only the humans and calculate the distance between the humans alone. The base neural network is Alexnet to estimate whether it is safe or not and then send it to the respective authority. This proposed idea using CrowdNet CNN and IoT combination will help find out peak hours of crowding and help control the spread of the disease during social distance violations without human intervention. Thus, social distancing in public places is automated using the real-time deep learning-based framework *via* object detection, tracking, and controlled disease.

Keywords: COCO, Convolutional Neural Networks (CNN), CrowdNet, Social Distancing, Ubidots, YOLO.

INTRODUCTION

The Coronavirus pandemic hit the world in the first week of March last year. It was long before 2020 when it began and spread. The initial spread can be attributed to lower test cases and virtually no social distancing. It is reported by Medical News Today that close distance means staying close to 6 feet from the nearest person. By the first week of March, it had spread to 90 countries. By mid-march, WHO declared it a global pandemic, and more than 115 countries declared it a national emergency state. While most healthcare organizations and medical experts were trying to develop an effective method to prevent the exponential growth of covid cases, the cases kept growing, and the death rates skyrocketed. Responding to this, the countries decided on lockdown and curfews to implement social distancing.

To maintain and improve our economy, working under social distancing was the only solution. A considerable disadvantage of lockdown is that it badly affects the economy, and livelihood of the people. In an article, the world economic forum stated that close to 114 million people lost their jobs due to COVID-19 making it the worst ever. For those who did not lose their jobs, salaries were cut. Business sectors like tourism and transport were enormously affected. Many cab drivers were not earning their payday. This raised anxiety and tension for the people to search for jobs and provide for their families again. Presently we can observe that markets and opportunities have started to open. Now, it will be an incentive for corporations, employers, and employees to collectively make an effort to maximize social distancing, minimizing social contact with others. This can only be tackled and succeeded collectively. Ensuring social distancing will decrease the cases drastically, and jobs and livelihood can turn back to normal. This research project aims to scrutinize different algorithms and find an effective social distancing measure among the masses.

Background of the Research Work

The current research utilizes Raspberry Pi 4 with 4 GB RAM for running the code, following rationale such as ARM Cortex A-72 as the processor- the A series of ARM processors are best to run Machine learning. Specifically, A-72 is intensively designed and used for running computer vision algorithms. It also has a high computed density and advanced branch predictor, making Raspberry Pi the best choice for our use case. The input is taken as a video for Raspberry Pi using raspberry-pi camera v1. The camera is capable of producing 5 Megapixel OmniVision resolution pictures and videos. The camera also supports 1080 pixel resolution with 30 frames per second, 720-pixel resolution with 60 frames per second, and 640* 480-pixel resolution for 60/90 recording. Currently, we are using 1080 pixel resolution with 30 frames per second for our video throughput. The Raspberry Pi 4 has a Broadcom BCM2711 SoC, which provides GPIO access and helps manage the devices like the camera. The current Raspberry Pi camera communicates on the CSI bus with the BCM2711 processor.

For processing the captured images, deep learning object detection techniques are used. Nowadays, many methods like detection-based, feature-regression-based, cluster-based, and neural network-based are available for crowd counting and object detection. A convolutional neural network (CNN) which consists of many hidden layers, is used for object detection. This is done by drawing bounding boxes around the object of interest. Feedforward neural networks or MLPs were among the first methods of object detection. However, due to certain limitations, it used many regions to detect and classify objects, which required considerable computational time, making it unsuitable for real-time object detection. To avoid this, Region-based convolutional neural networks, which extract about 2000 region proposals from an image, are favoured. Regional-based Convolutional Neural Network (RCNN) identifies these specific regions based on four parameters- colours, textures, varying scales, and enclosure. These parameters form a specific pattern recognized by the neural network and taken up as regions. Once the regions are extracted, they are resized and reshaped to match the input size of the CNN model. After that, this high-capacity CNN extracts a fixed-length feature vector from each region and forwards it to a set of class-specific, linear-specific vector machines (SVMs). The feature extractor is AlexNet since it can support an extensive model and utilizes very little time for training.

CHAPTER 10

A Game-Based Neurorehabilitation Technology to Augment Motor Activity of Hemiparesis Patients

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Abstract: Stroke recovery is the subsequent goal of stroke medicine. Rehabilitation and recovery research is exponentially increasing. However, several impediments impede the progress in the design of neurorehabilitation technology for stroke patient recovery. The conventional rehabilitation techniques for stroke recovery have some limitations like the absence of standardized terminology, poorly described methods, lack of consistent time frames and recovery biomarkers, reduced participation, and inappropriate measures to examine outcomes. Stroke recovery is challenging for many survivors. They require highly functioning and quick treatment accompanied by a gradual acceptance of brain improvement and human behavior. Therefore, there is an immediate need for neurorehabilitation technology to improve the quality of activities of daily life (ADLs) of those disabled. The method adopted is the design of neurorehabilitation technology using game-based systems that enhances the motor activities of hemiparesis patients.

Keywords: Arduino, Hemiparesis, Neurorehabilitation, Stroke, Visual feedback.

INTRODUCTION

Worldwide, Stroke is the second foremost reason for death and the third for disability. Low and middle-income countries are prone to stroke-associated deaths and disability-adapted life years. Stroke is the lack of oxygen to the brain cells due to the rupture or blockage of an artery. It is considered a risk factor for depression and dementia. Knowing the anatomy of the brain might assist in understanding the occurrence of the Stroke.

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Anatomy and Physiology of Brain

The brain weighs almost three pounds. It controls all the body functions. It involves interpreting the information and integrating the core of the mind and soul. A few of the many functions of the brain are intelligence, creativity, emotion and memory. It comprises the cerebrum, cerebellum and brain stem Fig. (**1**) shows the anatomy of the brain.

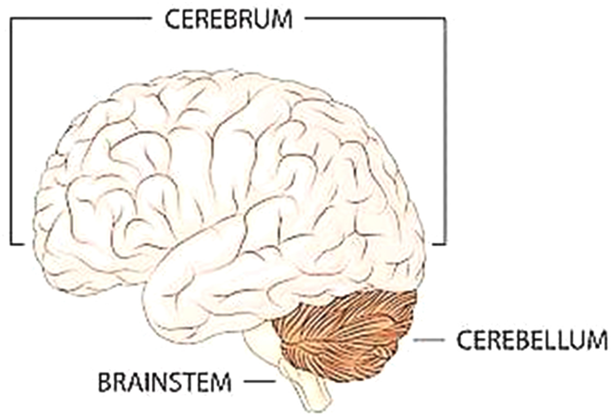

Fig. (1). Anatomy of the brain.

The cerebrum occupies the largest part of the brain. It comprises four individual lobes: the frontal, temporal, parietal and occipital. Each lobe posses varied functions, some of which may intersect.

Frontal Lobe

Motor function, problem-solving, spontaneity, memory, language, initiation, judgment, impulse control, and social and sexual behaviour.

Temporal Lobe

Memory, hearing, and understanding of speech and distinguishing between sounds and smells.

Parietal Lobe

Sensory comprehension, interpreting taste, touch, temperature, pain, movement and orientation.

Occipital Lobe

Visual stimuli.

The cerebrum, in the middle, can be divided into two parts. The left side of the brain, the left hemisphere, controls the right side of the body. The right side of the brain, the right hemisphere, controls the left side of the body. This provides a better understanding of why Stroke affects one side of the body. The lobes of the cerebrum is shown in Fig. (**2**).

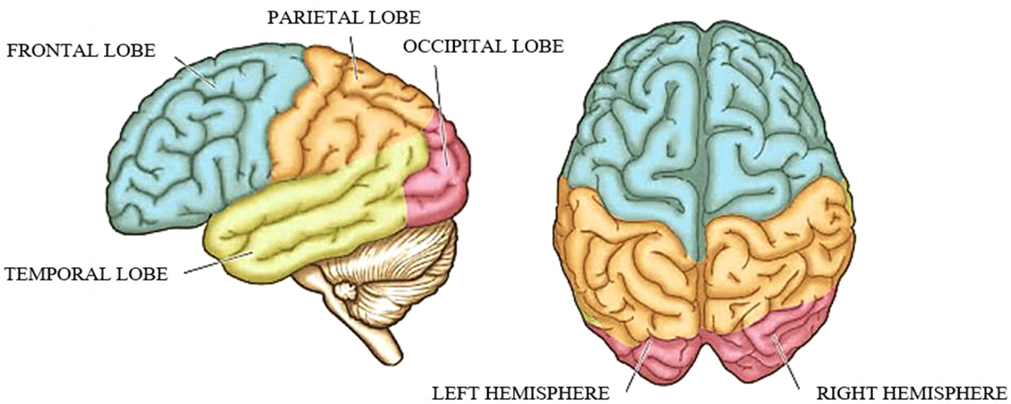

Fig. (2). Lobes of the cerebrum (Courtesy: sciencedirect.com).

The Cerebellum

The cerebellum resides behind the brainstem. The cerebellum modifies the movements controlled by the frontal lobe. It is responsible for fine motor movement, balance, and the brain's ability to determine position. Stroke occurring in this area may result in convulsive muscle movements.

The Brain Stem

The brain stem is otherwise known as Medulla Oblongata. It locates at the top of the spinal column. It regulates alertness, heart rate, blood pressure, and breathing. A stroke occurring in this area may disrupt breathing and result in sudden death.

Definition of Stroke

Sudden cessation of blood supply to the brain causes a stroke. An unexpected blockage in the artery (ischemic stroke) causes most of the strokes. Another stroke is due to the bleeding when a blood vessel bursts (hemorrhagic stroke). The region of the brain and the degree of damage determines the signs and symptoms of a stroke. The consequences of the stroke may be loss of sensation, weakness, or problems with seeing, speaking, and walking. The mortality rate for hemorrhagic stroke is seen as higher than for ischemic stroke.

CHAPTER 11

Smart Wearable Sensor Design Techniques For Mobile Health Care Solutions

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Abstract: In this chapter, we discuss the technological developments that have led to the clinical utility of smart wearable body sensors. Smart wearable sensors can enhance the physician-patient relationship, promote remote monitoring techniques, and their impact on healthcare management and expenditure. We explore how continuous health status monitoring can be achieved with the help of wireless sensors, wireless communication, microprocessors, and data processing algorithms. Furthermore, we also discuss the impact of using wearable sensor systems by infants and aged persons to alert parents/caretakers/clinicians. We also explore integrating smart wearable sensors and IoT to enhance the automatic monitoring and alerting systems for health care improvement.

Keywords: Alerting, Communication, Healthcare, Monitoring, Sensors, Vital parameters, Wearable, Wireless.

INTRODUCTION TO THE SENSOR TECHNOLOGY

A sensor is a device that will receive and respond to signals that could be produced by heat, light, motion, or chemical reactions. Sensors detect the presence of energy, energy changes, and energy transfer with the help of a transducer and convert the signals into readable format. Thermal sensors are used to gauge the environment's absolute temperature, how it affects two different metals, and the heat generated by chemical processes. Some mechanical sensors are meant to measure pressure, altitude, acceleration, and flow rate of liquid or gas. Electrical sensors are used for measuring resistance, voltage, current, and amount of electricity supplied/consumed. Chemical sensors are used for identifying the amount of oxygen present in the liquid or gas being analysed. Furthermore, they are used to identify the presence of carbon dioxide and any other as that needs to be monitored. Optical sensors are used to detect light,

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electromagnetic energy, the intensity of light, and infra-red radiation. Acoustic sensors are meant to measure seismic waves and wave velocity in the air or an environment. Apart from the above-mentioned sensors, we have motion sensors for detecting motion and sensors for measuring speed, atomic radiation, and monitoring human cells.

Biological sensors can measure carbohydrates, alcohol, acids, blood sugar levels, and air and water quality. They can also detect pathogens. Hence, they can be used for pollution control, general health monitoring, screening, analysis, and diagnosis of diseases. The materials used in biosensors [1] can be categorized into biocatalytic group (enzyme), bio-affinity group (antibodies, nucleic acid), and microbes (microorganism). Biosensors can be based on enzymes, tissues, immune systems, magnetic fields, heat, piezoelectricity, light, peptides, proteins, DNA, and genetic encoding. Biosensing technology has penetrated the food industry, agriculture, marine, defence, and clinical sector. In the medical field, biosensors are employed for a variety of purposes, including drug discovery, the diagnosis of viral and metabolic illnesses, the early detection of human interleukin, and the probing of gene expression. Nanomaterial-based biosensors [2] have outstanding physical and chemical properties and are being used for drug delivery [3], cancer treatment [4], and catalysis [5].

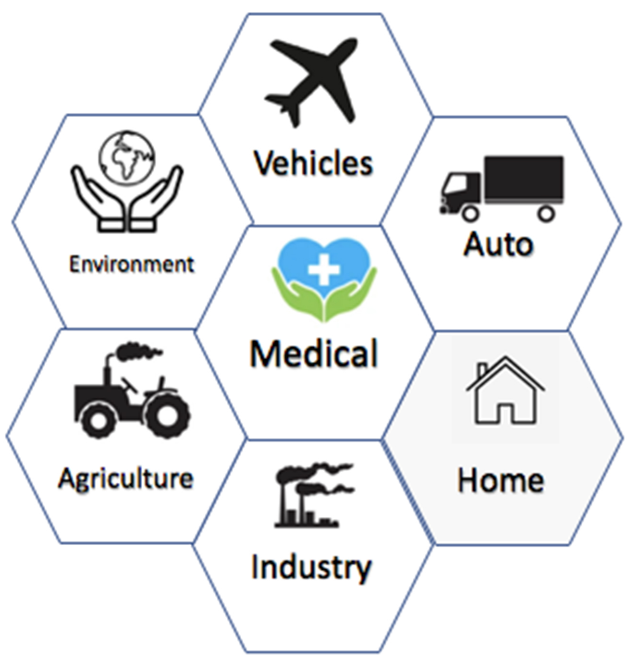

Fig. (1). Application of sensors.

Sensor technology has led to the development of devices that are used to acquire information based on the physical, chemical, or biological properties of an object and convert it into readable signals. Sensors are prominently used for measuring temperature, colour, gas, light, smoke, humidity, touch, soil moisture, IR, Ultrasonic, water flow, rain, heartbeat, proximity, EEG, conductance, and inertial. Sensors are ubiquitous and are at homes, offices, cars, and other work and living places to enhance our standard of living. Some of the common applications of sensors are turning on/off lights, room temperature adjustment, smoke or fire detection, garage door opening, and coffee making, as shown in Fig. (**1**).

DIFFERENT TYPES OF SENSORS AND THE PHYSIOLOGICAL PARAMETERS THEY COULD DETECT

Depending on the placement of sensors, they could be categorised as environmental, wearable, and implanted, as shown in Fig. (**2**). Moreover, Fig. (**3**) shows different types of sensors. Environmental sensors are generally used for measuring air temperature, humidity, air quality, pressure, dust concentration, light, and noise. Air monitoring of the environment will help us identify the level of contaminants to which a patient undergoing surgery will be exposed. Temperature sensors are used to adjust the working of the electronic gadgets to ensure that appropriate temperature is maintained so that the food in the warehouse, drugs in pharmaceutical storage, and their transportation are maintained appropriately. Humidity sensors are used in office environments for heating, ventilating, and cooling system control, generally used along with temperature sensors. Light sensors are used to automatically illuminate the rooms and control the intensity of the light. Motion sensors enable us to detect unauthorized movement in restricted areas and open doors automatically for thoroughfare entries.

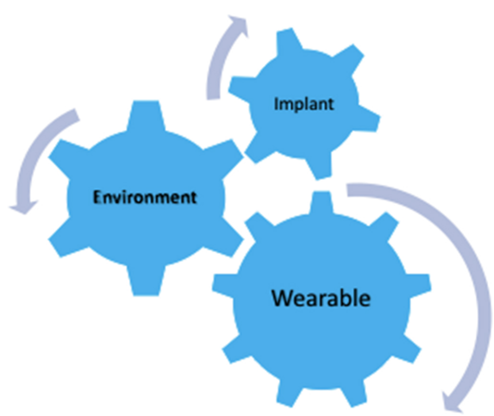

Fig. (2). Placement of sensors.

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SIVAKUMAR R.

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