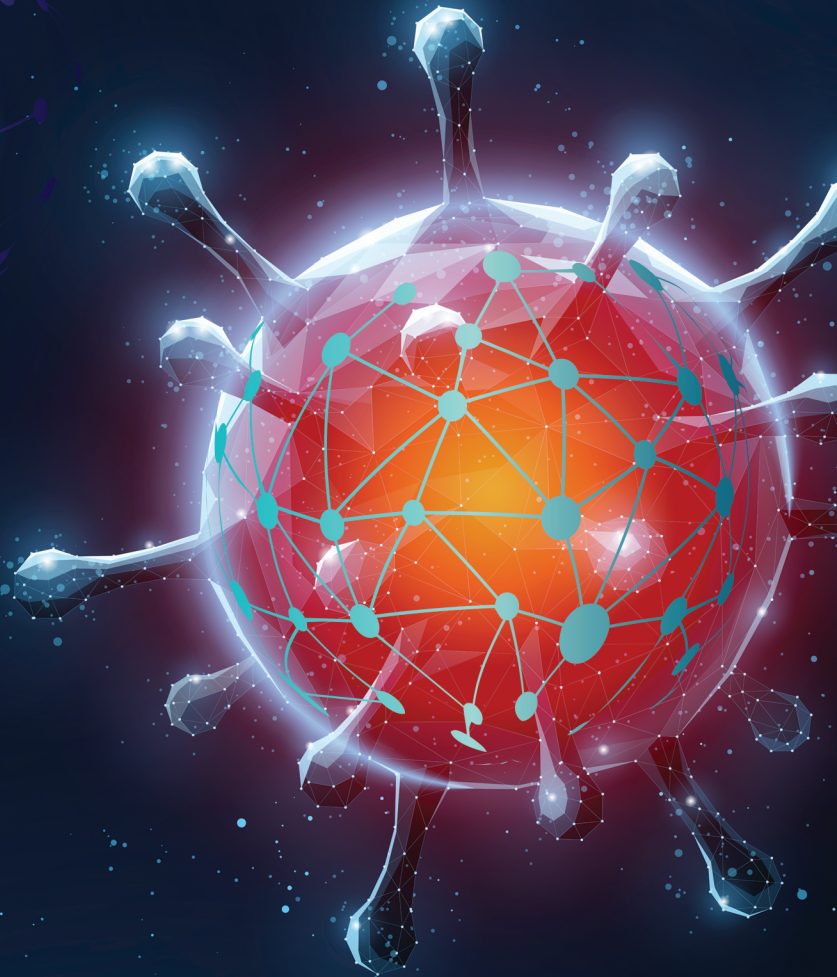


COVID-19 MONITORING WITH IoT DEVICES



Ambika Nagaraj

Bentham Books

COVID 19 – Monitoring with IoT Devices

Authored By

Ambika Nagaraj

*St. Francis College
Koramangala, Bengaluru, Karnataka 560034
India*

COVID 19 – Monitoring with IoT Devices

Author: Ambika Nagaraj

ISBN (Online): 978-981-5179-45-3

ISBN (Print): 978-981-5179-46-0

ISBN (Paperback): 978-981-5179-47-7

© 2023, Bentham Books imprint.

Published by Bentham Science Publishers Pte. Ltd. Singapore. All Rights Reserved.

First published in 2023.

BENTHAM SCIENCE PUBLISHERS LTD.

End User License Agreement (for non-institutional, personal use)

This is an agreement between you and Bentham Science Publishers Ltd. Please read this License Agreement carefully before using the ebook/echapter/ejournal (“**Work**”). Your use of the Work constitutes your agreement to the terms and conditions set forth in this License Agreement. If you do not agree to these terms and conditions then you should not use the Work.

Bentham Science Publishers agrees to grant you a non-exclusive, non-transferable limited license to use the Work subject to and in accordance with the following terms and conditions. This License Agreement is for non-library, personal use only. For a library / institutional / multi user license in respect of the Work, please contact: permission@benthamscience.net.

Usage Rules:

1. All rights reserved: The Work is the subject of copyright and Bentham Science Publishers either owns the Work (and the copyright in it) or is licensed to distribute the Work. You shall not copy, reproduce, modify, remove, delete, augment, add to, publish, transmit, sell, resell, create derivative works from, or in any way exploit the Work or make the Work available for others to do any of the same, in any form or by any means, in whole or in part, in each case without the prior written permission of Bentham Science Publishers, unless stated otherwise in this License Agreement.
2. You may download a copy of the Work on one occasion to one personal computer (including tablet, laptop, desktop, or other such devices). You may make one back-up copy of the Work to avoid losing it.
3. The unauthorised use or distribution of copyrighted or other proprietary content is illegal and could subject you to liability for substantial money damages. You will be liable for any damage resulting from your misuse of the Work or any violation of this License Agreement, including any infringement by you of copyrights or proprietary rights.

Disclaimer:

Bentham Science Publishers does not guarantee that the information in the Work is error-free, or warrant that it will meet your requirements or that access to the Work will be uninterrupted or error-free. The Work is provided "as is" without warranty of any kind, either express or implied or statutory, including, without limitation, implied warranties of merchantability and fitness for a particular purpose. The entire risk as to the results and performance of the Work is assumed by you. No responsibility is assumed by Bentham Science Publishers, its staff, editors and/or authors for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products instruction, advertisements or ideas contained in the Work.

Limitation of Liability:

In no event will Bentham Science Publishers, its staff, editors and/or authors, be liable for any damages, including, without limitation, special, incidental and/or consequential damages and/or damages for lost data and/or profits arising out of (whether directly or indirectly) the use or inability to use the Work. The entire liability of Bentham Science Publishers shall be limited to the amount actually paid by you for the Work.

General:

1. Any dispute or claim arising out of or in connection with this License Agreement or the Work (including non-contractual disputes or claims) will be governed by and construed in accordance with the laws of Singapore. Each party agrees that the courts of the state of Singapore shall have exclusive jurisdiction to settle any dispute or claim arising out of or in connection with this License Agreement or the Work (including non-contractual disputes or claims).
2. Your rights under this License Agreement will automatically terminate without notice and without the

need for a court order if at any point you breach any terms of this License Agreement. In no event will any delay or failure by Bentham Science Publishers in enforcing your compliance with this License Agreement constitute a waiver of any of its rights.

3. You acknowledge that you have read this License Agreement, and agree to be bound by its terms and conditions. To the extent that any other terms and conditions presented on any website of Bentham Science Publishers conflict with, or are inconsistent with, the terms and conditions set out in this License Agreement, you acknowledge that the terms and conditions set out in this License Agreement shall prevail.

Bentham Science Publishers Pte. Ltd.

80 Robinson Road #02-00

Singapore 068898

Singapore

Email: subscriptions@benthamscience.net



CONTENTS

FOREWORD I	i
FOREWORD II	ii
PREFACE	iii
CHAPTER 1 COVID -19	1
1.1. INTRODUCTION	1
1.2. SYMPTOMS	4
1.3. MEASURES	6
1.3.1. Demographic Information	6
1.3.2. Depressive Symptoms	10
1.3.3. Emotional Health	14
1.4. POTENTIAL IMPACT	17
1.4.1. Using Machine Learning	17
1.4.2. Using IoT Devices	18
1.5. OVERVIEW OF THE BOOK	18
CONCLUSION	19
REFERENCES	19
CHAPTER 2 SUPERVISED LEARNING ALGORITHMS	23
2.1. INTRODUCTION	23
2.2. SUPERVISED LEARNING ALGORITHMS	25
2.2.1. Support Vector Machine	25
2.2.2. Artificial Neural Network	28
2.2.3. Naive Bayes Method	31
2.2.4. K-nearest Neighbor	35
2.2.5. Decision Support System	39
2.2.6. One Rule (Oner)	52
2.2.7. Zero Rule (Zeror)	54
2.3. LINEAR REGRESSION	55
2.3.1. Random Forest	57
2.3.2. Gradient Boosted Regression Tree	63
2.3.3. Perception Back-Propogation	65
2.4. DRAWBACKS	67
2.5. FUTURE DIRECTIONS	68
CONCLUSION	68
REFERENCES	69
CHAPTER 3 SEMI-SUPERVISED ALGORITHMS	76
3.1. INTRODUCTION	76
3.2. SEMI-SUPERVISED ALGORITHMS IN HEALTHCARE	77
3.2.1. Linear Regression	86
3.2.2. Multiple Regression	92
3.2.3. Logistic Regression	95
3.3. DRAWBACKS	103
CONCLUSION	103
REFERENCES	104
CHAPTER 4 UNSUPERVISED ALGORITHMS	109
4.1. INTRODUCTION	109
4.2. CLUSTERING	121
4.3. DRAWBACKS	125

CONCLUSION	126
REFERENCES	126
CHAPTER 5 ROLE OF INTERNET-OF-THINGS DURING COVID-19	129
5.1. INTRODUCTION	129
5.2. ARCHITECTURE	130
5.3. ROLE OF IOT IN COVID-19	138
5.3.1. IoT – Healthcare	140
5.3.2. Role of IOT-Transportation in Covid-19	155
5.3.3. Role of IOT-Entertainment During Covid-19	158
5.3.4. Role of IOT-Retail	160
5.3.5. Role of IOT-Education During Covid-19	163
5.4. ROLE OF CLOUD	164
5.5. CHALLENGES	169
5.5.1. Awareness	169
5.5.2. Accesibility	175
5.5.3. Human Power Crisis	178
5.6. AFFORDABILITY	179
5.7. ACCOUNTABILITY	181
5.8. DRAWBACKS	196
5.9. FUTURE DIRECTIONS	196
5.9.1. Edge Architecture in H-IOT	196
5.9.2. Cryptography with Computing in H-IOT	198
5.9.3. Blockchain Based H-IOT	198
5.9.4. Machine Learning in H-IOT	199
5.9.5. Digital Twin in H-IOT	200
5.9.6. Unified Network Integration Framework	201
5.9.7. Context Aware Accessibility	202
5.9.8. Edge and Fog Computing	203
5.9.9. Sensors and Actuator Integration in H-IOT	204
CONCLUSION	205
REFERENCES	206
SUBJECT INDEX	214

FOREWORD I

Till December 2022, more than six hundred fifty-one million confirmed cases of COVID-19, whereas more than six million deaths were reported to WHO from all over the world. The SARS-CoV-2 virus and its variants spread mainly if there is close contact between people. In confined and enclosed places, short-range aerosol, airborne, droplet transmission happens at a conversational distance. It is recommended to avoid poor ventilation, and crowded indoor settings, and touching eyes, nose, or mouth after touching surfaces or objects. Anyone asymptomatic or pre-symptomatic carrying the virus can spread it. Singing, and breathing during the exercise can cause the virus to spread. Well-fitted three-layered masks, alcohol-based hand rubs, one-meter distance, cleaning hands, avoiding touching surfaces, and getting vaccinated can avoid SARS-COV-2 virus infection.

Monitoring public places, and hospitals, and understanding the overall situation in a country and the world is important to reduce the adverse impacts of Covid-19. Monitoring the situation, and venues without direct touch is possible through the Internet of Things (IoT) based solutions. The sensors, actuators, RFIDs, Near Field Communications, Unmanned Aerial Vehicles (UAVs) connected through the Wireless Sensor Network, and the Internet are the crucial elements in the monitoring of the COVID-19 situation.

Smart thermometers, Telehealth Consultations, wearables, robot assistance, and remote monitoring through the GPS-based ArogyaSetu are a few examples of IoT-enabled devices useful in COVID-19 monitoring. In particular, electronic sensors in the form of epidermal tattoos biomarkers cortisol, contact lenses for intraocular pressure, textiles face masks observe breathing patterns, airborne pathogens, inflammation markers, skin temperature, and metabolism monitoring, wristbands for the heartbeat and O₂ monitoring, and microneedle patches can help collect previously inaccessible physical and biochemical signals. Professor Steve Lindsay from Durham University developed the organic semiconducting (OSC) sensors that can detect fingerprints from body odor samples.

Author Dr. Ambika has good experience in the research field of WSN and academic experience. The content of the book is interesting and timely. Alone an IoT cannot bring insights and decisions based on the data collection, hence the author has elaborated machine learning techniques for the necessary actions based on the predictions. The predictions can help the government, social bodies, and individuals prepare themselves to handle the difficult situation of the pandemic. The content is highly relevant to extend the research in the health domain and to support the preparation of the policies in the governance of the country.

The pandemic created emotional and psychological impressions of low mood, tiredness, pessimism, poor sleep, and appetite, and feeling helpless, guilty, and hopeless, with a gradual reduction in work output. The IoT System monitoring the behavioral and allied patterns is equally important as that of social monitoring. The individual suffering from the infections needs to be monitored and counselled through the technological aspect. This will be an important input for all who would like to contribute and like to work in this direction.

Manoj Devare
Amity Institute of Information Technology
Amity University, Maharashtra
India

FOREWORD II

Covid sickness (COVID-19) is an irresistible illness brought about by the SARS-CoV-2 infection. The vast majority contaminated with the infection will encounter gentle to severe respiratory ailment and recuperate without requiring urgent treatment. In any case, some will turn out to be genuinely sick and require clinical consideration. More weak individuals and those with basic ailments like cardiovascular infection, diabetes, acute respiratory sickness, or disease are bound to foster difficult diseases. Anybody can get infected with COVID-19 and become genuinely sick or pass on at whatever stage in life. Observing and overseeing expected contaminated patients of COVID-19 is yet difficult with the most recent advancements. As a preventive measure, legitimate group checking, and the board frameworks are expected to be introduced in the open spots to restrict unexpected out brakes and confer further developed medical care. The quantity of new contaminations can be essentially diminished by taking on social distancing. In such scenarios, these smart IoT gadgets can become a very significant and important tool. The book introduces 5 chapters that discuss many interesting ideas that show how IoT devices are helping to tackle situations in the manufacturing and operational ecosystem of COVID-19.

Jyotir Moy Chatterjee
Department of Information Technology
Lord Buddha Education Foundation
Kathmandu-4600, Nepal

PREFACE

In patients with severe COVID-19, SARS-CoV-2 can cause not only antiviral immune responses to be activated but also uncontrolled inflammatory responses characterized by the significant release of pro-inflammatory cytokines. It can result in lymphopenia, lymphocyte dysfunction, and abnormalities in granulocytes and monocytes. Septic shock, severe multiple organ dysfunction, and infections by microorganisms may result from these immune abnormalities brought on by SARS-CoV-2. There is growing evidence that patients with viruses have resistant patterns closely linked to their disease progression. These patients exhibit lymphopenia, activation, and dysfunction of lymphocytes. They also have abnormalities in granulocytes and monocytes. They show elevated cytokines and increased immunoglobulin G (IgG) antibodies.

The well-defined scheme known as the Internet of Things (IoT) comprises digital, mechanical, and interconnected computing techniques. These devices can transmit data over a defined network without any human involvement. It is the network-compliant system of connected devices and operations, including; software, hardware, the network's connectivity, and any other necessary computer or electronic device that ultimately makes them responsive by supporting data alteration and collection. Utilizing an interconnected web made it possible for the healthcare system to be helpful for the proper monitoring of COVID-19 patients. The hospital readmission rate is reduced, and this technology improves patient satisfaction. The book is a description of how these devices aid in helping humanity.

Ambika Nagaraj
St. Francis College
Koramangala, Bengaluru, Karnataka 560034
India

COVID -19

Abstract: Corona is a single-stranded RNA virus that has been around since the late 1960s when it was first discovered. The Nidovirales order includes the Corona viridae family of viruses. The crown-shaped spikes on the virus structure's outer surface inspire the name Corona. The virus has affected chickens and pigs, but there hasn't been a significant human-to-human transmission. The virus's mode of communication and other related information are continually updated every few weeks, increasing uncertainty. A Chinese study suggests that the COVID-19 pandemic had a significant psychological impact on more than half of the participants. One more ongoing review from Denmark revealed mental prosperity as adversely impacted. According to the American Psychiatric Association's survey, nearly half of Americans were anxious. The chapter details the disease, its symptoms and measures taken.

Keywords: Covid-19, SARS-CoV-2.

1.1. INTRODUCTION

The most recent infectious disease to rapidly spread across the globe is coronavirus disease 2019, also known as COVID-19 [1, 2]. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [3] is the etiologic agent of COVID-19. The World Health Organization and the Public Health Emergency of International Concern declared the 2019–2020 pandemic due to the discovery of SARS-CoV-2 for the first time in Wuhan, China, in 2019. The disease began in Asia, but it has rapidly spread worldwide. It is the first coronavirus-related pandemic, according to the World Health Organization. Italy has risen to a prominent position in the international picture of infected patients due to the impressive growth in reported cases over time. Fig. (1) depicts the transmission of the disease. Fig. (2) represents SARS-CoV-2 virus depicting spike protein and mRNA core. Figs. (3-5) represent Integrative post-COVID symptoms model in non-hospitalized patients.

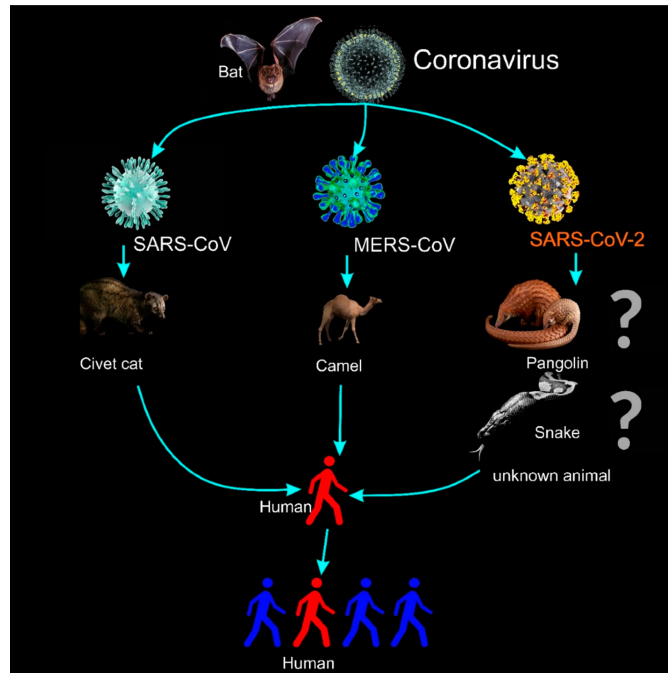


Fig. (1). Illustration for the transmission of coronaviruses [3].

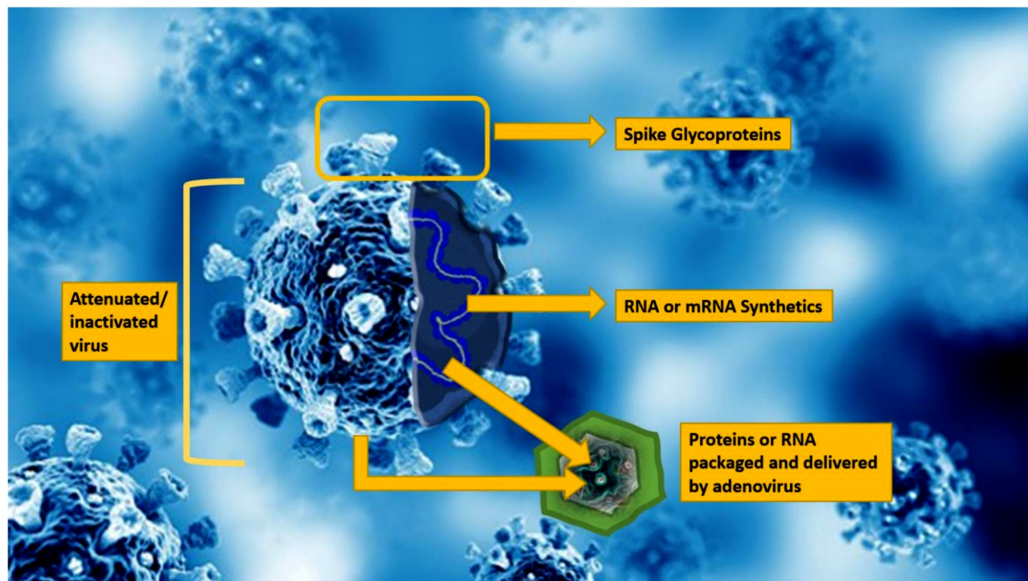


Fig. (2). Artist sketch of SARS-CoV-2 virus depicting spike protein and mRNA core [4].

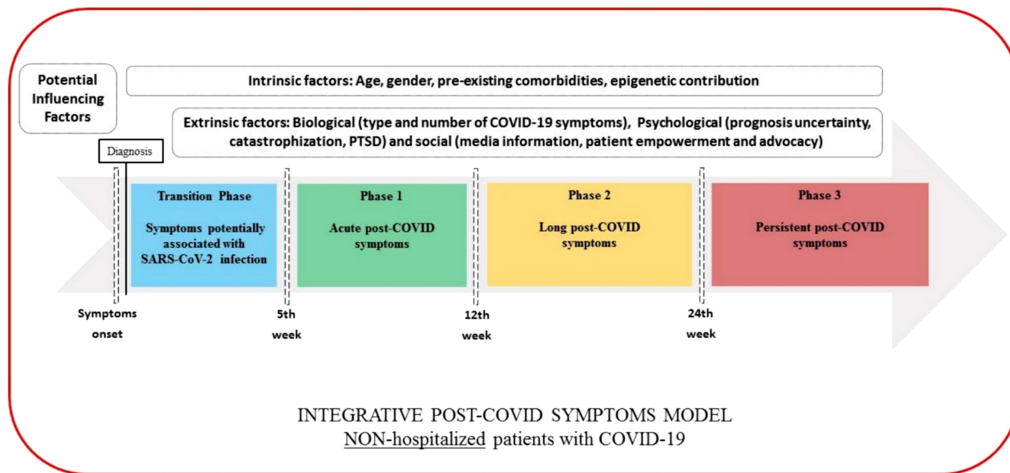


Fig. (3). Integrative post-COVID symptoms model in non-hospitalized patients showing transition phase (blue), and phases 1 (green), 2 (yellow), and 3 (red) of post-COVID symptoms. PTSD: post-traumatic stress disorder [5].

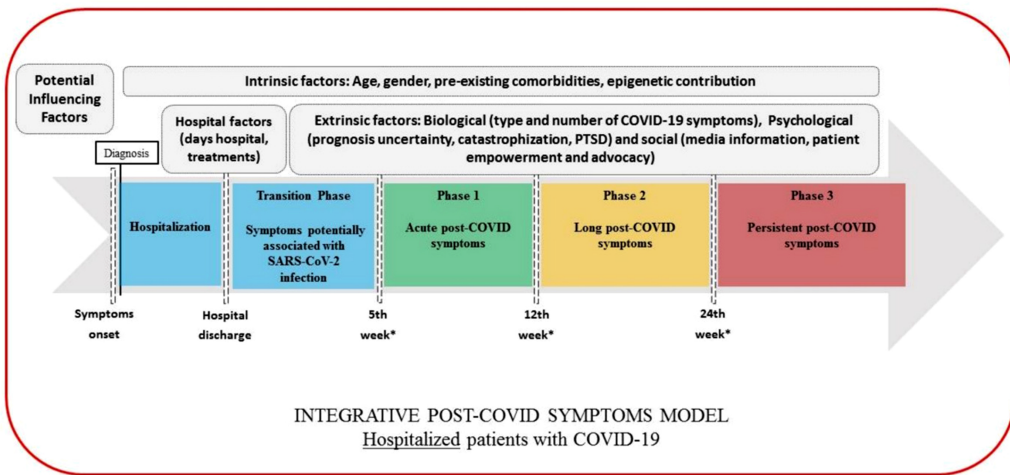


Fig. (4). Integrative post-COVID symptoms model in hospitalized patients showing transition phase (blue), and phases 1 (green), 2 (yellow), and 3 (red) of post-COVID symptoms. PTSD: post-traumatic stress disorder [5].

Supervised Learning Algorithms

Abstract: Numerous domains now employ learning algorithms. It has distinct performance metrics appropriate for them.. Based on a predetermined set of paired input-output training samples, a machine learning paradigm known as “Supervised Learning” is used to gather information about a system's input-output relationship. An input-output training sample is also known as supervised or labeled training data because the output is regarded as the input data or supervision label. Supervised learning aims to build an artificial system that can learn the mapping between input and output and predict the system's output, given new information. The learned mapping results in the classification of the input data if the output takes a limited set of discrete values representing the input's class labels. Regression of the information occurs if the output takes continuous values. The chapter details the various algorithms, technologies used and their applications.

Keywords: Known Label, Regression, Supervised Algorithms.

2.1. INTRODUCTION

Numerous supervised learning methods [2] have found applications in processing multimedia content and supervised learning accounts for a significant amount of machine learning research. In supervised learning, a mapping between a set of input variables X and an output variable Y is learned and used to predict outputs for data that has not been seen. The availability of annotated training data is the defining characteristic of supervised learning. The name evoked the concept of a “supervisor” who directs the learning system regarding the labels to associate with training examples. In classification problems, these labels are typically class labels. From these training data, supervised learning algorithms generate models that can be used to classify other unlabeled data. Fig. (1) represents contrastive learning pipeline for self-supervised training.

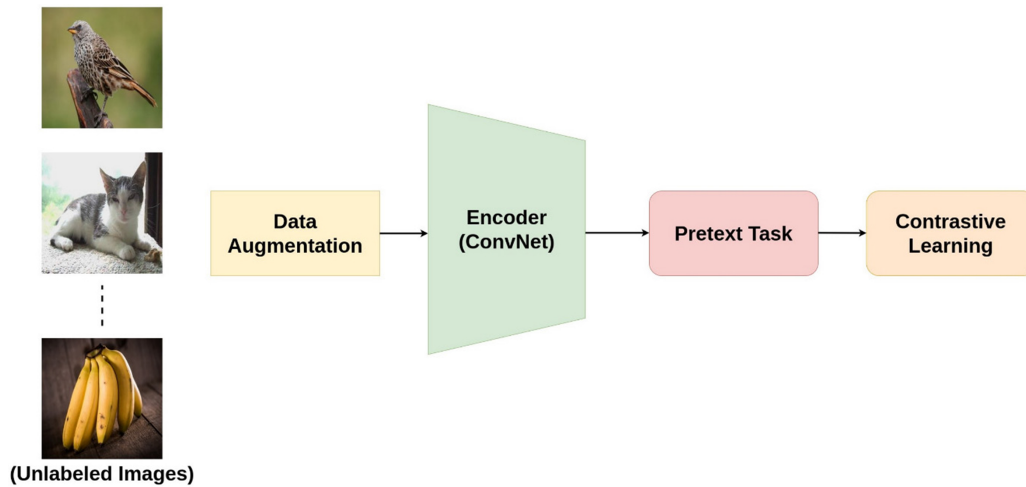


Fig. (1). Contrastive learning pipeline for self-supervised training [1].

The five main components of the proposed system model [3] are as follows: pre-processing, balancing, feature extraction, classification, and validation of the data are all included. The three-sigma rule, normalization, and interpolation of missing values are used to pre-process electricity data. The next model uses the pre-processed data for data balancing. The data are balanced using the Adasyn algorithm. Thirdly, the essential features are extracted from time series data using a VGG-16, and fourthly, the critical parts are given to FA-XGBoost for classification. A high-resolution accurate, intelligent meter data set provided by China's State Grid Corporation serves as the basis for testing the proposed system. 1032 are the input dimensions or features. The collection of data lasted for three years. Forty-two thousand three hundred seventy-two customers' electricity consumption data are included. The recently released data reveals the undisputed fact that 9% of all customers are victims of electricity theft. Fig. (2) depicts the same.

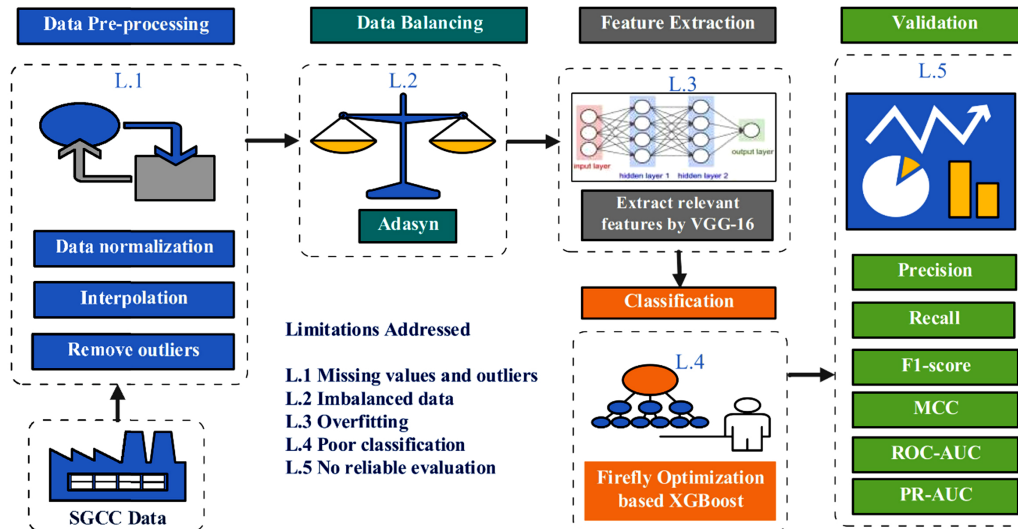


Fig. (2). Proposed model [3].

2.2. SUPERVISED LEARNING ALGORITHMS

2.2.1. Support Vector Machine

A computer algorithm known as a support vector machine (SVM) uses examples to teach itself how to label objects. By looking at many scanned images of handwritten zeroes, ones, and other digits, SVM can learn to recognize them. Additionally, SVMs have been successfully utilized in many biological applications. The automatic classification of microarray gene expression profiles is a common biomedical application for support vector machines. It can determine a diagnosis or prognosis by analyzing the gene expression profile derived from a tumor sample or peripheral fluid.

The speech recognition process [4] is improved by utilizing a hybrid Support Vector Machine (SVM) and Dynamic Time Warping (DTW) algorithm to contribute to the proposed framework. It is a smartphone-dependent system for speech recognition to execute a single command based on matching against the user command and the recorded speech templates. The proposed solution is a machine learning-based system for controlling smart devices through speech commands with an accuracy of 97 percent. To train the system to recognize these commands using the smartphone's microphone and voice command matching, each user should record these commands for various home appliances. Then, only a smartphone is used to send orders. A machine learning model is used to match

Semi-Supervised Algorithms

Abstract: Semi-supervised learning, or SSL, falls somewhere between supervised and unsupervised learning. The algorithm is provided with some supervision data in addition to unlabeled data. There are two primary learning paradigms in it. Transductive education aims to use the trained classifier on unlabeled instances observed during training. This kind of algorithm is mainly used for node embedding on graphs, like random walks, where the goal is to label the graph's unlabeled nodes at the training time. Inductive learning aims to develop a classifier that can generalize unobserved situations during a test. This chapter details different semi-supervised algorithms in healthcare.

Keywords: Semi-supervised algorithms, Logistic regression, Unlabeled data, Linear regression.

3.1. INTRODUCTION

The subfield of machine learning, known as semi-supervised learning, uses both labeled and unlabeled data for specific learning tasks. In semi-administered learning research, an extra presumption frequently included is group suspicion. The information addresses similar classes. The primary objective of semi-supervised learning is to use unlabeled data to improve learning methods. The relative performance of various machine learning algorithms is influenced by numerous decisions when evaluating and comparing them. Additional factors play a role in semi-supervised learning. First, it must decide which to label data points and which should remain unlabeled in many benchmarking scenarios. Second, one can evaluate the learner's performance on a test set that is entirely disjointed or on the unlabeled data used for training, which is, by definition, the case in transductive learning. In addition, it is essential to establish high-quality supervised baselines to evaluate the unlabeled data's added value accurately. Fig. (1) portrays the same.

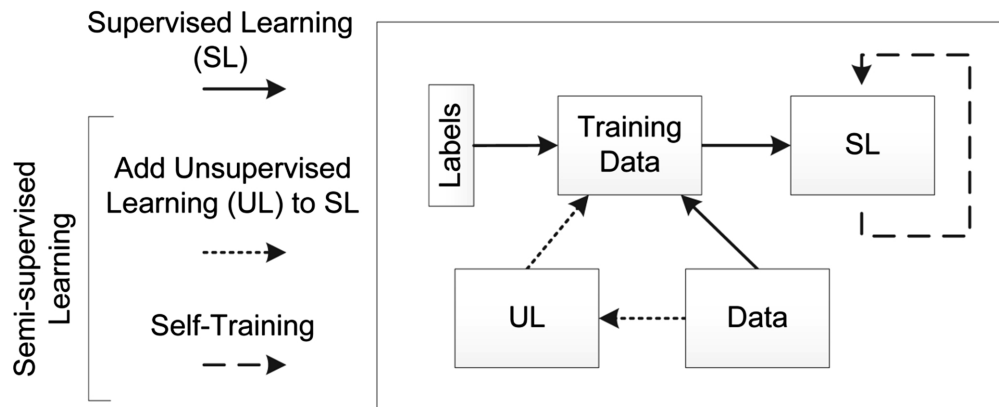


Fig. (1). Relation of semi-supervised learning (SSL) approaches to standard supervised learning [1].

3.2. SEMI-SUPERVISED ALGORITHMS IN HEALTHCARE

A type of Machine Learning (ML) technique is called semi-supervised learning (SSL). It is somewhere between administered and solo learning, *i.e.*, the dataset is somewhat named. It eliminates the disadvantages of supervised and unsupervised learning. Compared to unlabeled data, the labeled data should be shorter. The idea behind semi-supervised learning is that performance significantly shifts when labeled and unlabeled data are used together. The training set that is being used is more temporary. Usually, it is used to find outliers. Various information has materialized in medical care, including clinical information, sensor information, Omics information, *etc.* This kind of data requires multiple algorithms to be trained to make better predictions, and various mining techniques are used to find the most relevant features. Fig. (2) represents the Conceptual schematic for artificial intelligence in cardiovascular genetics.

The study [3] is a brand-new semi-supervised model for medical image classification. It uses an improved version of focal loss at the supervision loss to reduce sample misclassification. It incorporates a self-attention mechanism into the backbone network to learn more meaningful features for image classification tasks. It contains samples of intrinsic relationship characteristics. The mechanisms have student and teacher models. The model can spontaneously extract richer inherent information from representatives of unlabeled data and capture more crucial features of the current classification task. Finally, the improved focus loss is incorporated into the supervision loss, resulting in misjudged samples dominating the model's minimization goal and consequently improving the model's performance. For single-label classification, the ISIC 2018 dataset is

utilized. It contains 10,015 examination images of seven common skin lesions labeled as instances. Fig. (3) represents the same.

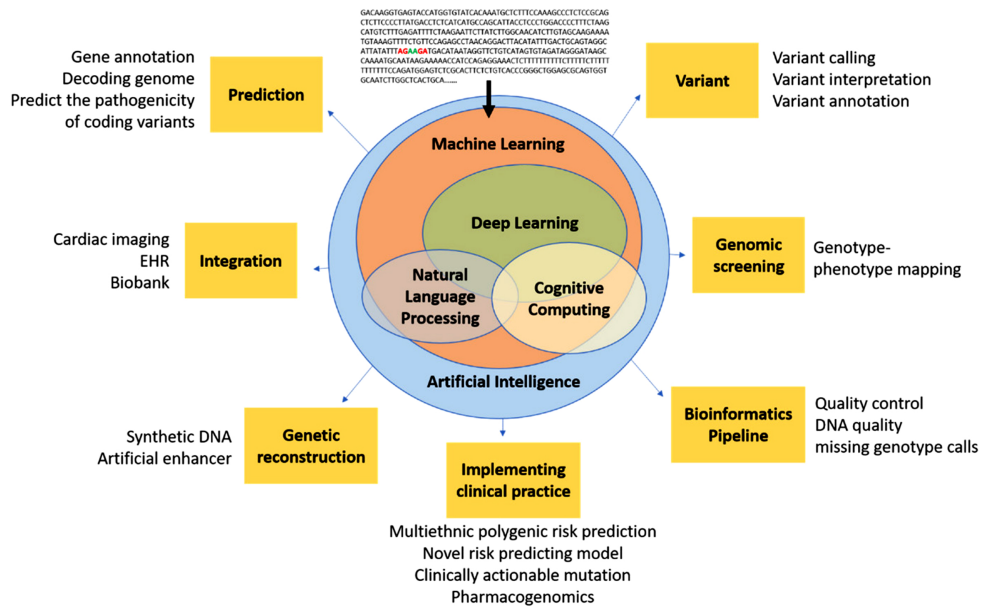


Fig. (2). Conceptual schematic for artificial intelligence in cardiovascular genetics [2].

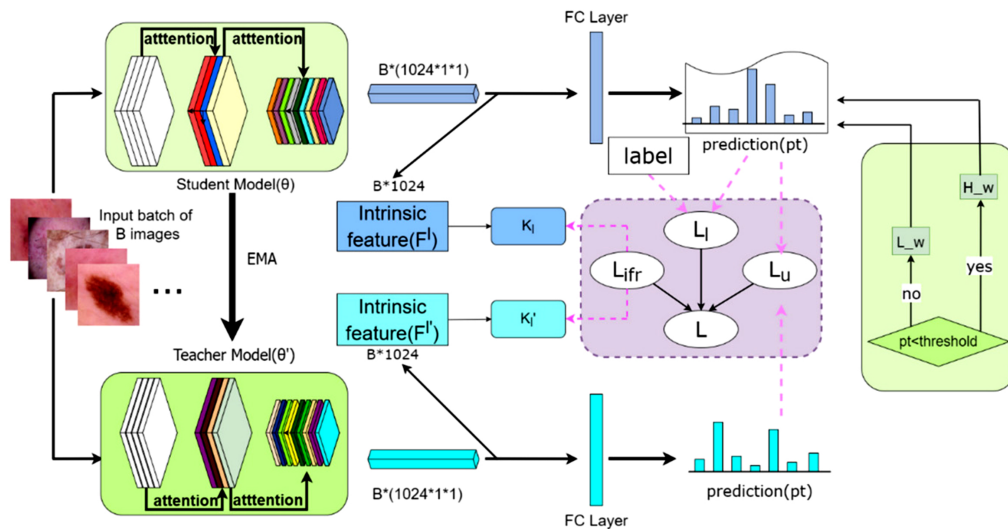


Fig. (3). Semi-supervised framework for medical image classification [3].

Unsupervised Algorithms

Abstract: The broad term “health care” refers to a system that focuses on improving medical services to meet the needs of patients. Patients, doctors, vendors, health companies, and IT companies all work to keep and restore health records in the healthcare industry. It uses machine learning. Healthcare analysis addresses a variety of diseases, including cancer, diabetes, stroke, and others. Both the labeled value and the target value are known. Training the data for unsupervised learning is also involved. Because the label value is either unknown or absent, it is impossible to evaluate the model's performance in unsupervised learning. The chapter details different unsupervised algorithms.

Keywords: Healthcare, Unsupervised Algorithms, Unlabeled Data.

4.1. INTRODUCTION

The process by which a network can study to signify some input designs in a manner that reproduces the numerical arrangement of the total collection of input designs or patterns is called unsupervised learning. The assumption of a function to define the hidden structure from unlabeled data is a machine learning charge. It is learning algorithms that lack labels to monitor learning and training. The algorithm accepts data and characteristics specific to each observation as inputs but not the desired output. Typically, unsupervised learning is used to divide the images into two sets or clusters based on inherent characteristics like color, size, shape, and so on. Because there is no external source of information for the network, it is referred to as either an adaptive learning algorithm or a self-organizing algorithm. It is contingent on the internal mechanism and local facts. The system receives the training figures and input patterns, which it organizes into categories or clusters. At the stage of the input layer, the system receives a group of training patterns or data. The output layer's nodes compete to adjust the network association weights, with the winner being the node with the highest value. The majority of algorithms for clustering and association make use of unsupervised learning.

A novel strategy [1] for unsupervised component condition identification is presented in this study. For modelling, it uses test cycle data of machine components under various faulty and healthy conditions. A test cycle is performed on any machine tool component without engaging the workpiece and outside machining times. It ensures that the requirements for generating and acquiring data are comparable. The test cycles' used to train the model and the model used to make predictions are the same. While the process of measuring and modeling remains the same for each machine component, each component undergoes its independent analysis. The method is shown to be effective for machine axes in this study. The test cycle's results in healthy and various faulty states are gathered for each axis. Similarly, a rotatory axis is rotated from its starting position to its limit of outward movement and then back to its starting position. There are four segments in each trajectory direction: a constant velocity segment, an acceleration ramp with a transient response, and a deceleration ramp with a quick response until the vehicle comes to a complete stop. It recreates the operating conditions necessary for detecting and quantifying anomalies. The test cycles are carried out with the standard process dynamics and velocities of the machine components that are currently in use. In addition, the test cycles are repeated multiple times to enable the detection of outliers in the recordings and reduce sample variation. The resulting data set is divided into test and training sets. Test cycle data of machine axes under unknown conditions are used to evaluate their health status during a prediction model deployment. The aggregated feature sets can train a model to learn similarities and differences between feature set samples. It predicts a time series sample of an unidentified machine condition. The time series is divided into the defined ROIs. After selecting and calculating the model's retained features, the model scalar normalizes the resulting characteristics and applies the trained HDBSCAN model to the unknown feature set. Fig. (1) Solution approach for both model training and prediction of test cycle samples.

This work [2] first shows that the unsupervised learning paradigm can also be used to classify images of HEp-2 cells. A deep convolutional autoencoder with an encoding-decoding method for feature extraction is proposed. It can identify the two components of the network: the encoder, which gradually reduces the input's spatial size, and the decoder, which gradually expands the input's spatial scope while decreasing its depth. As we progress within the network until we reach the space of the latent representations, the input image is systematically down-sampled before the decoding or up-sampling begins. It has the outcome that the organization loses the spatial data of the picture in many layers. This distortion complicates the reconstruction process. It employs two approaches utilized in the segmentation issues. The encoder's maximum pooling process entails storing the positions of the selected activations. The unpooling process in the decoder will only consist of setting all remaining values to zero and placing the activations at

the stored posts. It obtained the outcomes by using the SNPHEp-2 dataset. There are five types of cells in the SNPHEp-2 dataset-homogeneous cells, coarse and fine speckles, cells with nuclei, and cells with the centromere. This dataset has two levels of fluorescence intensity: powers, both positive and negative. It used all 40 different cell samples to extract the images. Twenty of the forty specimens were utilized for the training sets, while the remaining twenty were used for the testing sets. There are separate 905 and 979 cell pictures for the preparation and testing sets. Fig. (2) denotes the same.

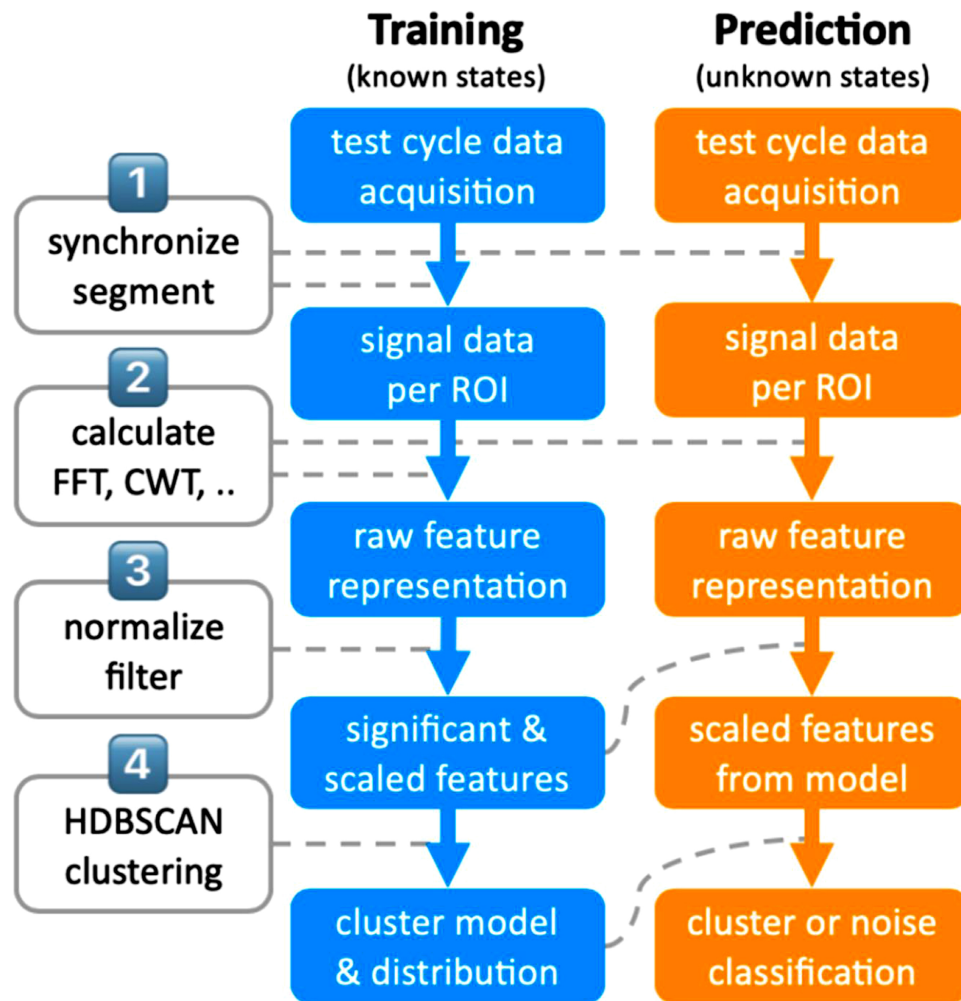


Fig. (1). Solution approach for both model training and prediction of test cycle samples [1].

Role of Internet-of-Things During Covid-19

Abstract: In December 2019, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection that caused pneumonia spread to Wuhan City, Hubei Province, China. Fever, dry cough, and fatigue are typical clinical manifestations of COVID-19, frequently accompanied by pulmonary involvement. SARS-CoV-2 is highly contagious, making most people in the general population susceptible to infection. One of the most popular technologies, the Internet of Things (IoT), has much potential for combating the coronavirus outbreak. It has transformed real-world objects into sophisticated virtual ones. The Internet of Things (IoT) aims to connect everything in our world and assist users in controlling the objects in their immediate vicinity and keeping them informed of their current state. IoT devices sense the environment without human or machine interaction and send the gathered data to the Internet cloud. Tens of millions of devices are connected *via* the Internet of Things (IoT), and the number of connected devices is rapidly increasing.

The chapter aims to highlight the role of IoT devices in detecting Covid-19. It details the different architectures of the system. Various domains, like the role of machines in healthcare, transportation, entertainment, retailing, and education, are detailed. It addresses challenges - awareness, accessibility, human power crisis, affordability, and accountability. Some of the future directions managed including edge architecture, cryptography, blockchain, machine learning, digital twin, unified network integration, context-aware accessibility, edge and fog computing, and sensor and actuator integration are summarized.

Keywords: Coronavirus 2, Covid-19, Detection, IoT, Prevention, SARS-CoV-2.

5.1. INTRODUCTION

Due to its significance in numerous applications in education, industry, and commerce, Internet of Things research looks promising. The process of connecting machines, equipment, software and things in our environment is what the Internet is all about. Instead of thinking of the Internet as a collection of connected computing devices, it is now thought of as a collection of related things in a person's living space, like machines, transportation, goods, business storage, and home appliances, among other things. The living space contains more objects than the entire human population. An item in the Internet of Things [1] should

have a unique address for each component. The technology known as radio-frequency identification (RFID) is used for communication. There should be a way for IoT [2] to determine its users are and their rights and restrictions. Fig. (1) portrays the applications of IoT.

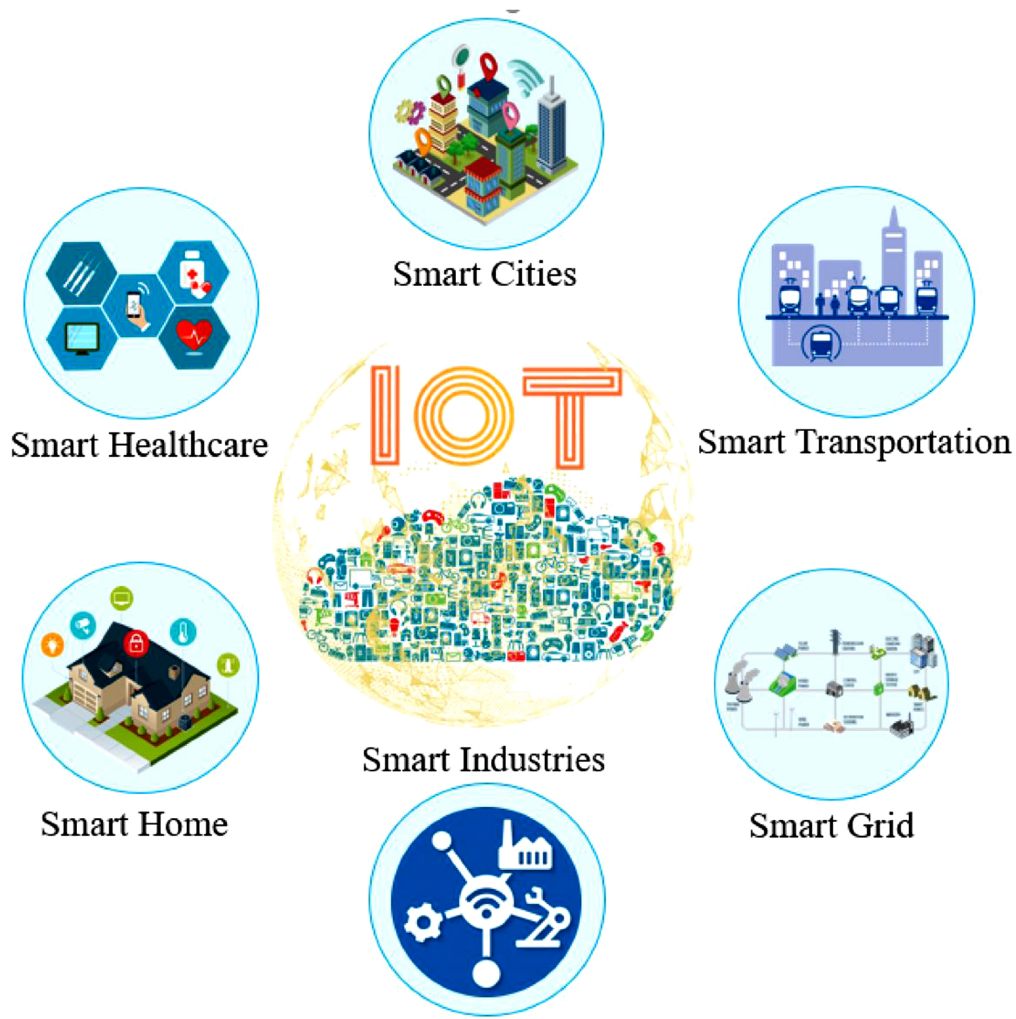


Fig. (1). IoT-based applications [3].

5.2. ARCHITECTURE

The term “Internet of Things” (IoT) [4] refers to a system of devices that are connected, have computing power (smart objects), can be identified, and can transfer data over a network without the need for human interaction. To be

incorporated into everyday objects, IoT [5, 6] requires a few components. The incorporation of silicon components into metallic or fabric materials has the potential to broaden the field of component miniaturization and integration. Fig. (2) represents the 3-tier architecture of IoT.

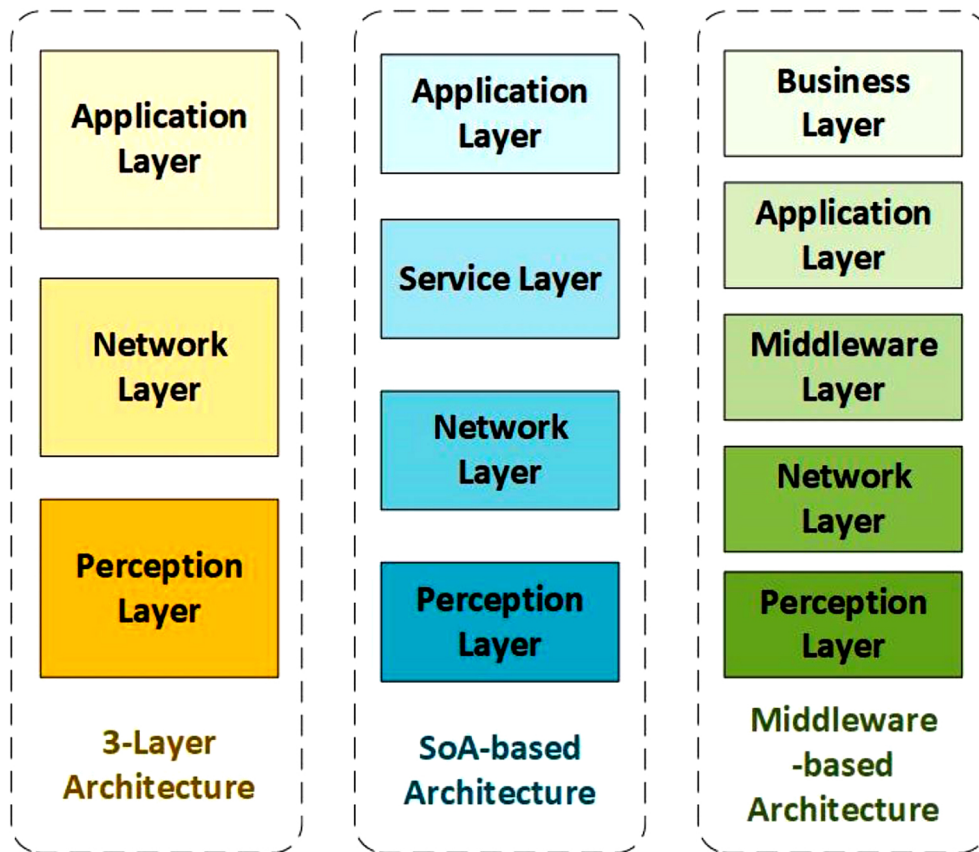


Fig. (2). - 3-tier Architecture [7].

The perception layer collects and processes information to interact with the environment and represents the physical level of objects. This level has things that can communicate with the outside world. The data provided by the perception level must be transported to the application layer by the network layer. It includes all of the protocols and technologies that enable this connection. The software required to provide a particular service is all contained in the application layer. Databases, analysis software, *etc.*, that are used to store, aggregate, filter, and

SUBJECT INDEX

A

Acute 112, 179
 coronary syndrome 112
 respiratory syndrome 179
 Adaptive neuro-fuzzy inference system
 (ANFIS) 83
 AI-based decision support system 48
 Application(s) 10, 14, 23, 40, 63, 68, 85, 132,
 135, 138, 164, 166, 167, 169, 185, 186,
 187, 195, 196
 computer-based 40
 machine-learning 63
 programming interface (API) 10, 135, 138,
 185
 Automobiles 146, 155, 177
 autonomous 146
 Autonomous solutions 163

B

Bipolar disorder 186
 Blockchain 185, 186
 network 185, 186
 technology 185
 Bluetooth 52, 174
 connection 52
 sensor 174
 Breast cancer 43, 62, 79
 prognosis 43
 screening 79

C

Cancer 85, 176
 lung 85
 prostate 176
 Cardiac dysrhythmia 101
 Cardiovascular disease risk 34
 CARLA outcome measure 47
 Centroids 121, 177

 census block 177
 computed 121
 Characteristics, sociodemographic 99
 Chronic obstructive pulmonary disease
 (COPD) 169, 186
 Cloud 9, 10, 15, 16, 61, 83, 135, 148, 152,
 153, 164, 165, 166, 167, 169, 174, 183,
 184, 187
 and artificial intelligence 169
 based hardware 166
 computing 61, 183
 computing layer 184
 database 16, 174
 execution 167
 miner 83
 public 165
 Cluster(s) 84, 123
 activity 84
 formation 123
 Clustering algorithm 121
 Common recognition and identification
 platform (CRIP) 187, 188, 189
 Computer 25, 39, 156
 algorithm 25
 program 39
 vision 156
 Computing power 130
 Conditions 15, 32, 37, 61, 67, 91, 133, 138,
 186, 196, 204
 heart 67
 neuropsychiatric 15
 respiratory 138
 Consumption, fuel 163
 Convolutional 29, 30, 81, 82, 120, 147, 151,
 156, 167
 neural network (CNN) 29, 30, 82, 151, 156,
 167
 pathways 29
 Coronary atherosclerosis 101
 Coronavirus, acute respiratory syndrome 1,
 129

Subject Index

COVID-19 1, 6, 10, 11, 12, 19, 103, 138, 141, 155, 168, 179
detection 141
outbreak 103
pandemic 1, 12, 19, 138, 155, 179
pandemic learning process 168
patient health-monitoring framework 10, 11
vaccination 6

COVID-19 infection 4, 12, 67
acute 4

Cryptography 129, 198

D

Data mining 17, 39, 47, 125
methods 125
purposes 47

Deep reinforcement learning (DRL) 112

Devices 18, 52, 61, 68, 123, 136, 140, 142, 146, 167, 171, 196

biomedical 146, 171

fog 142

medical 18, 140, 196

mobile 52, 61, 68, 123, 136, 167

Digital behavior change interventions (DBCIs) 203

Diseases 1, 4, 10, 14, 17, 18, 19, 30, 35, 37, 49, 53, 55, 57, 61, 63, 87, 92, 103, 186, 196, 198

cardiovascular 35, 49, 63

chronic kidney 37, 57

chronic obstructive pulmonary 186

coronavirus 1, 10, 18

inflammatory bowel 92

meningococcal 103

non-communicable 14

respiratory 18, 87

Disorders 14, 15, 91, 100, 199, 202

mental 14, 15

neurological 199

DNA, meningococcal 103

DUR, computer-based 88

Dynamic time warping (DTW) 25

Dysfunction 6

multiorgan 6

E

ECG signal detection 191

COVID 19 – Monitoring with IoT Devices 215

Electrocardiograms 90, 174

Electronic 13, 47, 80, 101, 103, 112, 113, 153

health record (EHRs) 13, 47, 101, 153

medical records (EMR) 103, 112, 113

stethoscope 80

Electrophoresis 4

F

Fatigue 18, 129, 142

Fever 18, 129, 146

Fluorescence intensity 111

Function 26, 32, 59, 96, 109, 136, 142, 166, 181, 187, 190

cardiac 26

network logic 136

G

Gas emissions 163

Gastroenterology 194

GHz frequency band 132

Global positioning system (GPS) 13, 15, 68, 85, 191

H

Health 10, 61, 168, 184

crisis 10

data 61, 168, 184

Healthcare 18, 31, 40, 65, 68, 83, 95, 101, 103, 109, 125, 159, 174, 183, 184, 200, 201, 202

industry 18, 65, 68, 83, 95, 103, 109, 159, 200, 201, 202

IoT devices 174

monitoring systems 184

professionals 31, 40, 101, 103, 125, 174, 183

Home 117, 158

products, innovative 158

services, innovative 158

WiFi router 117

Honghu hybrid system (HHS) 166, 167

I

Image processing 81, 146

Infectious diseases 1, 179

Influenza 150, 179
 avian 179
 Integrated medical information system (IMIS)
 197, 198
 Integration, cloud-based data 45
 Internet 17, 138, 140, 164
 based network 164
 of medical things (IoMT) 17, 138, 140
 IoMT devices 194
 IoT 8, 10, 155, 163, 174, 183
 aware healthcare monitoring system 174
 risk management 183
 services 8
 technologies 163
 transportation 155
 wearable 10
 IoT-based 13, 49, 130, 150, 192
 applications 130
 real-time health application 192
 sensors 13
 smart screening 150
 system 49
 IoT sensors 10, 184
 medical 184

K

Knee replacement surgery 119

L

Learning 28, 30, 32, 34, 41, 76, 85, 89, 116,
 120, 125, 126, 164, 165, 183
 transductive 76
 algorithms, mining-related machine 32
 Logistic regression (LR) 47, 64, 76, 95, 96,
 102, 103
 analysis 102, 103
 LTE transmission 184
 Lung tissues 168

M

Machine learning 17, 48, 174
 system 174
 techniques 17, 48
 technology 17
 Mask 146, 157
 detection 157

recognition 146
 MATLAB 10, 83
 implementation tool 10
 programming language 83
 Medical 17, 97, 150
 sensors 150
 services 17, 97
 Medical care 41, 67, 77, 201
 framework 67
 processes 41
 Medical records 35, 103, 120, 176, 184, 191
 electronic 103, 120
 Mental health 103
 Method, snowball 48
 Microcontroller, cloud-based 10
 Microphone, smartphone's 25
 MMG sensor 62
 Mobile application 52, 136, 142, 187
 iOS 136
 Modern sensor fusion techniques 88
 Monitoring, biosensor-based 200
 MySQL database 132

N

Naive bayes method 31, 32
 National health insurance corporation (NHIC)
 63
 Natural 96, 157
 logarithm 96
 masking settings 157
 Neural network 10, 28, 29, 34, 65, 81, 82,
 117, 120
 artificial 28, 117
 Neurons, biological 28
 Noise 26, 62
 environmental 26
 removal 62
 Nutrition 7, 39
 examination survey 39
 variables 7
 Nutritionists 97

O

Online 87, 161
 groceries 161
 healthcare services 87
 Organization, drug 117

Subject Index

OWL ontology 172
Oxygen 146, 170
 levels 146
 saturation 170

P

Pain 94, 119
 chronic 94
 knee 119
Pandemic 1, 8, 155, 160, 162, 165, 166, 167, 179
 coronavirus 160
 coronavirus-related 1
 influenza 179
Parkinson's disease 62
Piezoelectric stethoscope 80
Pneumonia 18, 98, 129
 critical 18
Polymerase chain reaction 103
Post-COVID-19 syndrome 4, 6
Post-traumatic stress disorder 3, 4
PRISMA guidelines 8
PSICOST research association 48
Psychiatric disorders 5, 99
Public health 89, 167, 179
 crisis response 179
 information system 167
 interventions 89
Python 50, 56, 61, 116, 141, 144, 156
 function 116
 libraries 56
Python programming 56, 62, 112, 157, 158
 language 62, 112, 157, 158
Pytorch library 30

R

Radiological tests 50
Radiologists 97, 144
Ramifications 181
Random 57, 58
 decision forests 57
 forest-based 58
Regression techniques 88
RT-PCR 18

COVID 19 – Monitoring with IoT Devices 217

S

Safety 18, 90, 138, 150
 climate 90
 public 18
 regulations 138
SARS 19, 101
 CoV virus 19
 outbreak 101
SARS-CoV-2 1, 2, 67, 129, 138, 168, 196
 genome sequence 168
 virus 1, 2, 138
Security 36, 117, 157, 158, 162, 164, 183, 185, 191, 193, 198
 blockchain-based 193
 context (SC) 36, 183
 end-to-end 191
 guideline 183
 internet 198
Security context 183
 healthcare information 183
 information's 183
Semi-supervised learning (SSL) 18, 19, 76, 77, 79, 103
Sensor(s) 14, 15, 52, 53, 54, 68, 84, 112, 117, 118, 134, 135, 137, 138, 142, 146, 150, 151, 170, 171, 174, 183, 184, 186, 197
 biomedical 135
 biometric 54, 146
 data 14, 53, 84, 112, 134, 150, 171, 174
 environmental 134, 135
 fusion algorithm 146
 glucose 52, 54
 oxygen-based 142
 virtual 171
 wearable 174
Sensor network 61, 138, 173, 204
 system 204
Service(s) 95, 132, 136, 137, 173
 location-aware 173
 monitored data 137
 nursing 95
 web 132, 136, 137
Sign, vital healthcare 195
Signal(s) 26, 28, 37, 54, 62, 118, 123, 132, 174
 analog 54
 degradation 118
 integration 28
 variation 118

Smart 173, 158, 168, 185
 contracts, blockchain-based 185
 gateway, wearable 173
 home services 158
 PLS Version 168
 Smartphone 14, 53, 118, 150, 169
 app 150, 169
 based depressed mood prediction system 14
 device's sensor streams 118
 stores 14
 transmits data 53
 Social 7, 10, 137, 157
 isolation 10
 media platforms 7, 157
 networks 137
 Software, smartphone-based 180
 Solar corona 19
 Somatization 91
 SparkFun sensor 146
 Speech recognition process 25
 Statistical package for social science (SPSS)
 9, 87, 102, 161
 Storage 14, 61, 129, 133, 135, 173, 190
 business 129
 devices 61
 Support vector machine (SVM) 25, 34, 79, 88
 System 25, 59, 169, 181, 196
 eGAP 59
 healthcare-focused 196
 learning-based 25
 medical 181
 microelectronics 169

T

Techniques 37, 43, 59, 63, 68, 77, 85, 86, 118,
 125, 156
 applied data mining 125
 boosting 63
 computer vision 156
 deep-stacked autoencoder 118
 effective clustering 59
 mining 77
 Technologies, wireless sensor network 204
 Thrombolysis 47, 90
 therapy 47
 Transportation 129, 155, 156, 163
 public 155
 Transportation 166, 177
 network 177

restrictions 166

U

UCI 38, 39, 67, 82
 repository 38, 39, 67
 standards 82
 web portal 67

V

Video frames 173
 Virtual 141, 167, 184
 climate 141
 machines (VMs) 167, 184
 Virus1, 146, 196
 single-stranded RNA 1
 transmission 146, 196
 Vision transformer 141
 Visual analysis system 115

W

Web of Science databases 6
 Wi-Fi 13, 53, 61, 117, 136, 137, 152, 164, 191
 application 61
 certified product 117
 network 137
 Wireless 16, 61, 132, 134, 151, 169, 170, 185,
 191, 204
 body area network (WBAN) 134, 169
 communications 61, 132
 connection 16
 data transmission 191
 human body-connected 191
 sensors 185, 204
 Wisconsin breast cancer 67

Z

ZigBee 132, 142
 networking protocol 132
 protocol 142
 Zoom cloud meeting 168



AMBIKA NAGARAJ

Prof. Ambika is an MCA, MPhil, and Ph.D. in computer science. She completed her Ph.D. from Bharathiar University in the year 2015. She has 18 years of teaching experience and works for St. Francis College, Bangalore. She has guided BCA, MCA, and M.Tech students in their projects. Her expertise includes wireless sensor networks, the Internet of things, and cyber security. She also delivers guest lectures. She is a reviewer of books, conferences (national/international), encyclopedias, and journals. She is an advisory committee member of some conferences. She has many publications in the national & international books and journals, conferences, and encyclopedias. She has some patent publications (national) to her credit and she is also registered for copyright in the computer science division

