Advancement in Healthcare Data Analysis: Unveiling the Power of Machine Learning for Predictive Modeling and Future Challenges

[1]M.Janaki [2]Dr.K.Rajalakshmi [3] Dr.S.Mahalakshmi [4] K. Uma

[1]Senior Assistant Professor, Department of BCA, New Horizon College , Bangalore- 103
[2]Assistant Professor, Department of MCA, CMR Institute of Technology , Bangalore-37
[3]Assistant Professor, Department of BCA,
Dharmamurthi Rao Bahadur Calavala Cunnan Chetty's Hindu College, Chennai-72
[4]Assistant Professor, Department of Computer Science , Mount Carmel College, Bangalore

Abstract: Healthcare analysis of data is growing as one of the most interesting research areas in recent decades. Sensor data is collected by a variety of wearable and smart devices. Processing this initial data manually is really difficult. The use of machine learning has evolved into an important data processing technique. To more precisely predict the results of healthcare data, artificial intelligence (AI) employs a number of statistical approaches as well as intricate algorithms. The application of ML algorithms for examining different kinds of healthcare information is then discussed in this study. The purpose of this work is to help researchers gain a complete understanding of automatic learning as well as its utilization in healthcare facilities. We proposed a classification of machine learning-based systems in healthcare in this research. We expect that this review paper will help experts become acquainted with the most recent research on ML applications in medicine, identify obstacles in this field, and focus on deep learning approaches in the future because they are extremely powerful tools for addressing healthcare concerns.

Keywords: Health Care Monitoring, Sensor Data, Medicine, Artificial Intelligence, Machine learning

I.INTRODUCTION:

Artificial intelligence (AI) refers to the development of computer-based systems that can perform tasks akin to human intelligence [2]. Machine learning methods are regarded as advanced technology with a high potential for data analysis, and they have been effectively implemented in a variety of sectors such as fault detection, quality prediction, defect categorization, and visual examination. Wearable devices may include a range of sensors that constantly track different human signals, such as temperature sensors, acceleration sensors to monitor optical detectors and physiological sensors. We think that this review article will assist researchers in becoming acquainted with the most recent findings on ML uses in healthcare and in identifying their own challenges in this field. Artificial intelligence is used in healthcare to make accurate and timely decisions by gathering insights from unstructured information. [7,8]. In Fig. 1, different data sources in healthcare are shown in a visual representation.

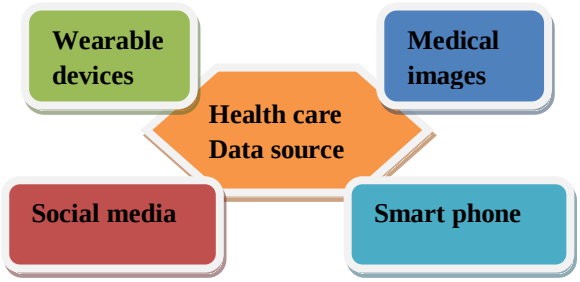

Fig .1. Various healthcare data source information

1.1 Paper Organization:

The breakdown of the paper's structure is as follows: The first part is the problem definition and contribution of the research paper; the second part of this chapter addresses the topic of the literature review; and the third part of this

chapter provides the need for health care in machine learning. The fourth part of the chapter discusses the analysis of the algorithm. The fifth section provides an overview of the conclusions. Fig. 2 shows the outline of the paper chart.

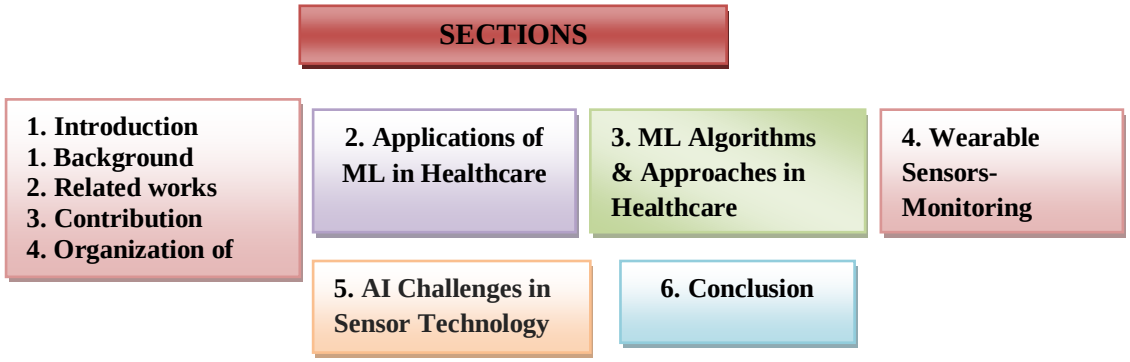

Fig. 2. Organization of this work

1.2. Description of the problem:

The goal of this study is to assist researchers in expanding their knowledge of ML as well as its potential uses in the medical sector.

1.3. Paper's contribution:

1. To investigate machine learning (ML) and how it's utilized in healthcare.
2. Machine learning Algorithms and Approaches in Healthcare
3. Wearable Sensor –Monitoring in healthcare
4. Discussion on AI challenges in sensor technology

2. Literature review:

The goal of this literature review is to examine the literature and find past work and previous studies in the field of healthcare technology for analyzing healthcare data received from various sources using various machine learning algorithms. The purpose of this literature review is to consolidate the information obtained from past research and to offer a generalized view of all the material gathered from the studies concerning data and algorithms used for healthcare data analysis.

Table 1 summarizes the machine learning applications in healthcare and mentions the inferences drawn from the work in a brief manner.

Table 1. Contains a list of review articles on ML applications in healthcare.

Articles	Authors	Task	Description
[15]	**Olsen.et.al**	Classification, Prediction, Diagnosis.	The deployment of predictive techniques in the treatment of heart disease was investigated. For this purpose, the authors provided an introduction to computational intelligence and its possible applications in wellness. Experts additionally addressed a few critical elements to consider while developing machine learning-based models. Based on their application, automated learning approaches are then categorized into three major groups: evaluation, categorization, and cardiovascular disease prediction. The authors then examined the challenges and drawbacks of computing technology in healthcare.

[1]	**M. Javaid et al.**	Physical and Mental Health Monitoring	This paper describes ML and its application in healthcare, followed by a discussion of the related attributes and suitable ML components for a healthcare framework. At last, it outlined and discussed the significant uses of machine learning in health.
[6]	**K.shailaja**	Prediction of breast cancer	This paper discusses numerous machine learning algorithms for predicting diseases such as cardiovascular disease, tumors in the breast, type 2 diabetes, and diseases of the thyroid.
[22]	**K.Butchi Raju et.al**	Heart Disease Prediction	The authors present a novel IOT and fog computing-based smart cardiovascular disease prediction system that uses a novel heuristic-based deep learning approach and medical sensors such as glucose level, respiration rate, and oxygen level.
[24]	**L. P. Malasinghe et al**	Remote patient monitoring	Remote monitoring of patients uses modern communication and sensor technologies to monitor vital signs. It ranges from monitoring chronically ill patients to victims of accidents, with contactless monitoring requiring only the patient to be present within a few meters.
[25]	**H.K. Bharadwaj, A. Agarwal**	Diagnosis of diabetes	This study's use of AI-based learning algorithms in H-IOT has demonstrated scientific proof of efficiency and feasible usability. Each of these applications' restrictions and drawbacks have also been addressed.
[26]	**Christopher Toh**	Medical images for the purpose of analysis medical intervention	Machine learning is being used in healthcare to improve patient outcomes by analyzing health data from the Internet of Things. It is currently being applied to medical imaging, natural language processing of medical documents, and genetic information. However, there are challenges in data formatting due to the many forms of medical information.
[14]	**Senerath Mudalige Don Alexis Chinthaka Jayatilake**	Prediction of Lung Cancer, chronic disease	This paper addresses a number of machine learning strategies and methodologies utilized for decision-making in the medical field, as well as the present role of technology in clinical systems. Deep learning approaches based on neural networks have done well in the field of scientific computing, and are widely used because of their great forecasting precision and dependability.
[31]	**M. Ferdous**	Diabetes disease	The Author discussed the history of diabetes as one of the most frequent and dangerous ailments, causing a plethora of other serious complications. It typically affects the function of the kidneys, blood vessels, and nervous system. ML could help in the initial identification of the condition, possibly avoiding fatalities.

Various ML applications in healthcare are shown graphically in figure 3

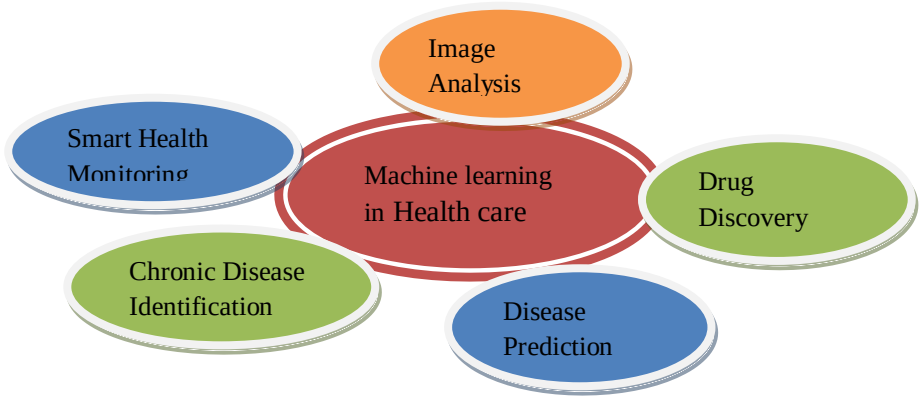

Fig .3. Various ML applications in healthcare

3. METHODOLOGY

3.1. Health Care in Machine Learning

Healthcare is an industry that has been significantly impacted by advancements in machine learning. Machine learning techniques have the potential to revolutionize various aspects of healthcare, including diagnosis, treatment, research and administrative tasks.Today, healthcare has become one of the fastest developing businesses, and it is experiencing a massive global overhaul and shift. Because of the large amount of data collected for each patient, algorithm that employ machine learning in healthcare offer an enormous number of possibilities.

3.2. Machine Learning:

AI includes ML as a subset. It is capable of detecting trends in information in real- time. Models built on machine learning (ML) can learn through experimentation and automatic learning without specific programming [9, 10]. Demographic information, pictures, test findings, genomic information, medical records, and sensor data are a few examples of health data.

3.3. Significance in the Health Care Sector:

Medical professionals use ML as a tool to care for patients and handle clinical data. Hospitals and healthcare organizations have used ML to overcome a variety of difficulties [19, 20]. Each approach seeks to teach computers how to perform specific jobs.

A large number of academics work on machine learning and artificial intelligence in the medical field every day. We need to revisit additional studies in this area because of significant advances in algorithms for learning and their applications in medicine [8].

3.4. Machine Learning Characteristics in Healthcare:

It emphasizes the computerized training environment's intellectual and caring traits for its holistic medical facilities. In Fig:4 ,it also involves help from a number of sophisticated and digital tools, such as cloud servers' data performance and AI. The creation of electronic medical records, even at a reasonable expense, further impressively benefits the healthcare industry.

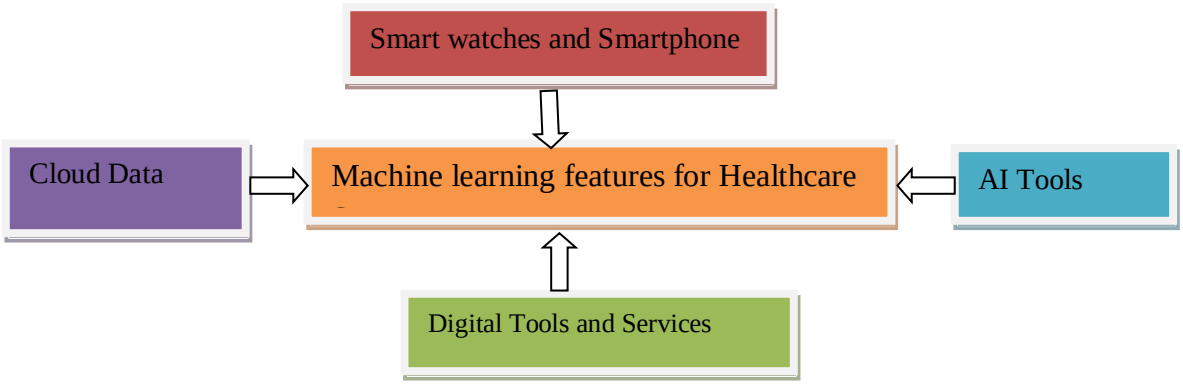

Fig. 4. Machine learning-based aspects in healthcare facilities

In Table 2, the current papers on ML applications in healthcare are summarized in detail.

Table 2. lists some existing papers on the characteristic of machine learning applications in healthcare.

Authors	Applications	Description
Yu-Jin Hong[27]	Smart watches and Phones	Two wireless accelerometers and an RFID sensor are used to classify five human body states and detect RFID- tagged objects with hand movement.

S. J. Lewis et al[28]	AI tools	We investigate how AI and its various forms, such as the use of ML, may alter the delivery of imaging techniques, from workflow to data collection, authentication, and analysis.
A. Sarirete et al[30]	Digital Tools and Services	The rise of the internet has affected every aspect of human life, notably industry, medical treatment, governance, business, and social awareness.
Forum Desai et al.[29]	Cloud Data System	Health Cloud is a system that uses devices and cloud-based technology to monitor the health of patients with cardiac disorders.
S. Paraschiakos et al.[33]	Activity Recognition	The Growing Old TOgether Validation (GOTOV) project was designed to assist several nobilities and healthy aging investigations among older persons.

3.5. Approaches and Algorithms for Machine Learning: An Overview

A. Supervised Machine learning:

In supervised learning, labeled data for training is typically employed. The training outcome of the data is "labeled" and includes one or more sources. Models employ labeled discoveries to assess themselves while training to improve their ability to predict novel information [11]. Classical problems are common in medicine, with a focus on classification and regression techniques. Clinical conditions involve categorizing a patient's condition based on a specific collection of symptoms, while regression problems focus on forecasting numerical results such as the predicted length of stay in a hospital.

B. Unsupervised machine learning:

Unsupervised computing is an algorithm for machine learning in which classifiers learn by working on raw data sets followed by being let to operate on them autonomously.[3]

Unsupervised AI is used to detect patterns in raw data without labels [3]. K-means clustering, rule-based association mining, topic modeling, and dimension reduction techniques are examples of unsupervised learning methods [5].

C. Reinforcement learning (RL):

RL is the process of generating a system that performs better by incorporating input from the environment and potentially making improvements. It involves interacting with the world and learning from it without the aid of humans. It is a continuous procedure.Fig:5 show the graphic image of various kinds of machine learning methods.

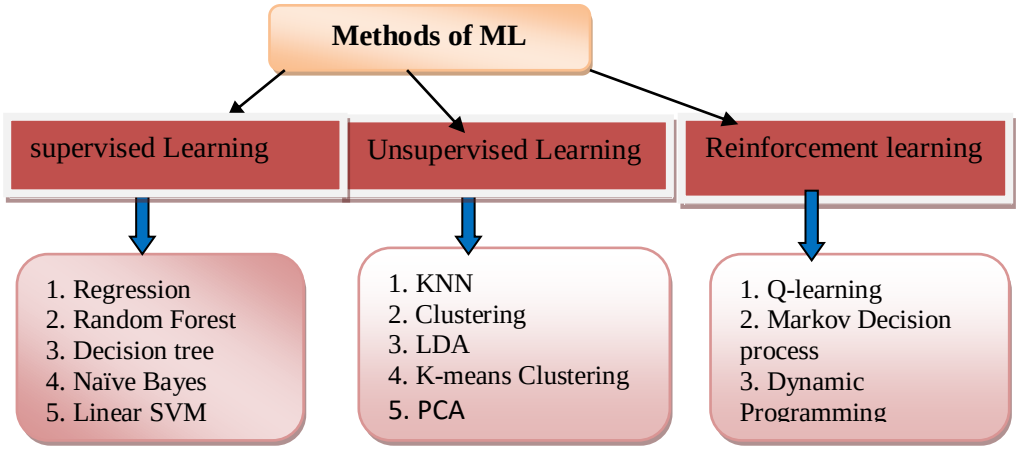

Fig . 5. Types of Machine learning

In table 3 we showed the approach of machine learning methods advantage, disadvantage, ideas and method in tabular form.

Table 3. Analysis of Machine learning methods for classification

Approach	Advantage	Disadvantage	Idea	Method
Supervised[13]	Appropriate for complex tasks	Have two sessions and a long training period.	The statistical learning theory used in this technique maximizes the space between the divider and the data.	Support Vector Machine
Supervised[9]	They execute computations quite well.	The effect of the feature group determined on accuracy	The Decision Tree emphasizes the sliding window and utilizes static time series data characteristics..	Decision Tree
Unsupervised[35]	Low complex issues of computation. Large datasets with high efficiency.	Inadequate cluster overlap efficiency	The clustering of n samples into k classes is known as an unsupervised classification technique. Data is passed to desired cluster based on distance from centre.	K-means

In table 4 the machine learning purpose and dataset, examples given in tabular form.

Table 4. Various techniques of learning

Strategy	Objective	Metadata & Examples
Supervised learning[21]	determining the connection between inputs and outputs, and predicting the testing set's label	Collection with labels, Regression
Unsupervised learning[3]	Finding data trends and organizing data samples	Collections without labels, Clustering and Dimension reduction
Semi-Supervised [35]	The algorithm is trained on a dataset that contains both labeled and unlabeled data.	Clustering , Classification
Reinforcement learning[35]	Interacting with the environment to determine the optimal course of action	Classification and control

4. Discussion of the Findings

1. ML-Based Healthcare Analysis:

There is an enormous amount of information on the patient's health in the medical field. As a result, machine learning (ML) provides a framework for discovering patterns in massive amounts of data and utilizing algorithms to estimate patients' outcomes. Using predictive modeling for medical purposes assists users to learn with regards to the efficacy of current activities and deciding the optimal approach for the individuals based on the state of their health.

2. Types of Health-Related Information:

Diagnostic data, sensor information, and other types of knowledge are becoming increasingly common in healthcare. Several mining approaches are used on this type of data to identify the more essential parts, and then alternative algorithms must be built for improved projections of the future.

2.1. Clinical Evidence:

Clinical technology that supports decisions aids in the analysis of large volumes of data in order to diagnose a condition, decide on the next stage of therapy, identify possible issues, and boost comprehensive therapy productivity. ML is a strong approach that helps professionals perform their jobs more efficiently and quickly, as well as reducing the likelihood of making an unreliable assessment or recommending inadequate therapy, and it has grown in favor in recent years [1].Medical records include information from electronic health records and are made up of lab test results, hay fever, radiographic images, and other information, and are collected as the patient is undergoing ongoing care.

In table 5 we summarized the clinical data which includes algorithms and results

Table 5. Machine learning was used to analyze a summary of clinical data.

Authors	Data set	ML Algorithm	Results	Future scope
Wengert.et.al [16]	Clinical	SVM, Linear and Logistic regression	XG boost yields the finest outcomes.	Less data was used, and some characteristics that affected imaging features and RCB prediction were included.
Chayan Kuma Karvey et.al[18]	Clinical	SVM,KNN,DNN	DNN generated greater precision (78%).	In the future, attention should be paid to effective feature selection methods for surgical projection.
Venkatesan et al [23]	Clinical	Decision tree	Decision tree gives the best result 97%	In Future we should use different algorithm to get more accuracy.
Ayse Demirhan[7]	Clinical	back-propagation neural network, self-organizing maps, support vector machines and k-nearest neighbors	SVM show better result than other methods	To improve accuracy, we should utilize a new algorithm in the future.

2.2 Wearable Sensors:

Wearable sensors are like mini-computers that can sense and collect data about things like your movement, heart rate, body temperature, sleep patterns, and more. They use different types of sensors, such as accelerometers, gyroscopes, heart rate monitors, temperature sensors, and GPS, to capture this information. The sensors in wearable devices continuously monitor and record data while you wear them. They can track your physical activity, monitor your health and fitness, and provide feedback or insights based on the data collected.

Two groups can be used to categorize how sensors are used in healthcare systems:

2.2.1. Patient Monitoring In Medical Situations

Low-power detection devices track and record an individual's health indicators (e.g., pulmonary oximetry, rate of breathing, and temperature) in physiological surveillance activities. These kinds of applications can be created and

deployed in a variety of situations, including emergencies, hospitalized tracking of patients, and ongoing surveillance from home for the elderly.

2.2.2. Chronic and Elderly Patients in Home Care and Nursing Homes are Monitored.

The elderly people must have access to high-quality, affordable healthcare that allows them to live freely. The social and financial burdens associated with an ageing populace can be lessened with at-home healthcare.

By using WMSNs, at-home treatment can be provided. It can be used to address the broader issue of gathering biological and behavioral data from patients for assessment, tracking, and long-term condition treatment. These wireless sensors can be placed in a patient's home setting to offer real-time and thorough surveillance of their activity and welfare. When paired with communications technology such as mobile phones and the Internet, the sensor network may notify family, caregivers, and doctors, as well as establish trends and uncover variability in the patient's health [4]. In table 6 sensor data summarization shown in tabular form.

Table 6: Machine learning is used to analyze sensor data that has been summarized.

Authors	Datasets	Task	ML Algorithm	Performance parameter
Muhammad Shoaib[17]	Sensor data	Activity Recognition	Decision tree,SVM,KNN	Accuracy, precision, False positives, negatives and F-Measure
J.Hayano ,H.Yamamoto [21]	Sensor Data	Nap Monitoring	Auto correlated wave detection with threshold	Recall, Precision,Accuracy
Muhammed syafrudin[34]	IOT based sensor data	Real time Monitoring system	(DBSCAN)-based outlier detection and Random Forest classification	Precision, Recall, Accuracy
Zhenghua Chen[32]	Smartphone	Robust HAR orientation	CT-PCA and Online SVM	Augumented, Bi-Directional
Syed K.Baskar[12]	Smartphone	Activity Recognition	Neural Network	Accuracy, Recall

5. Open Issues:

Wearable devices have gained significant popularity in recent years and have shown great potential for various applications, including machine learning .However, there are several obstacles and challenges that need to be addressed when using wearable devices in machine learning applications. Some of these obstacles are :

In Fig 6 obstacles of wearable devices in ML applications shown in diagrammatic manner.

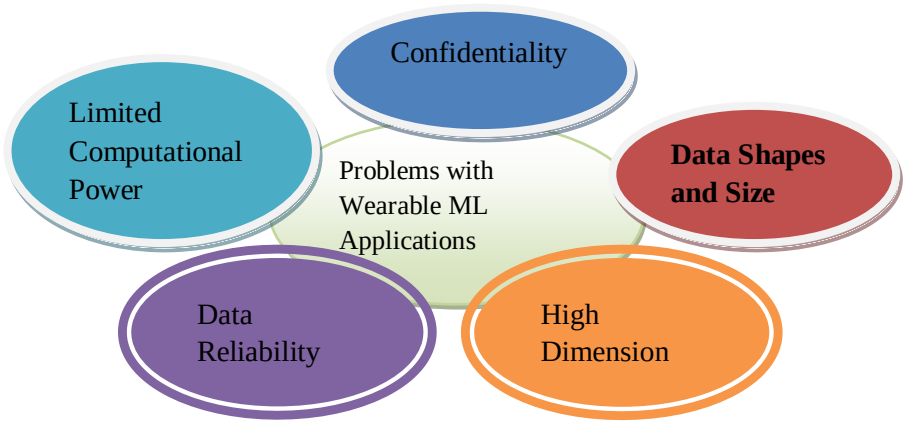

Fig. 6. Problems with Wearable ML Applications

5.1 . Data comes in a variety of shapes and sizes:

Real-world information is disorganized, insufficient, and available in a variety of forms (structured and unstructured).

5.2. Confidentiality:

Because confidential data could be exploited to identify patients, researchers must think about safety when developing machine learning (ML) frameworks. Protecting the privacy of patients is an important concern, investigators should consider when doing extra research.

5.3. Data Accessibility:

Big data sets are usually required to build machine learning models. When the datasets are huge, these models perform well and have minimal error.

5.4. High Dimension:

Real-time databases in health care are multi-dimensional. This problem increases learning time, complicates models, and causes over fitting. As a result, methods that use ML should constantly take this into account. Additionally, there are a few successful strategies for lowering dimensionality, Identifying features, and selecting features. More research in this field is needed to develop more effective methods for reducing complexity.

5.5. Data reliability:

Another thing to bear in mind is that every intentional error in recording the information increases the rate of error. As a result, the correctness of the information is a key issue. When medical professionals are not diligent enough when categorizing specimens of data, several problems can develop. Approaches to data preparation may significantly decrease these difficulties while increasing dataset fidelity.

5.6. Limited Computational power:

Most wearable devices have limited computational capabilities due to their small size, low power consumption requirements, and limited battery life. This poses challenges for running complex machine learning algorithms that typically require substantial computational resources .Developing efficient and lightweight algorithms that can run on wearable devices is crucial.

6. Conclusion:

Healthcare has become one of the fastest -growing industries in the twenty-first century. We explored methods of using machine learning for medical care in this paper. To that end, experts reviewed machine learning as well as discussed its potential applications in healthcare. Finally, we looked at various machine learning (ML) healthcare solutions and analyzed their benefits and drawbacks. We anticipate that this study will provide academics with a good overview of the use of AI in healthcare as well as familiarization with the most recent studies on ML usage in medical practice. We will aim to focus on methods of deep learning in the future because they are incredibly effective tools for addressing challenges in healthcare. This study also looked into the use of wireless sensing networks in the medical sector. The application of wireless sensors in healthcare systems has been separated into

two major groups: patient monitoring in clinical environments and geriatric client surveillance at home and in nursing homes.

Acknowledgment

None.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Reference:

[1]. M. Javaid et al., "Significance of machine learning in healthcare: Features, pillars and applications", International Journal of Intelligent Networks 3 (2022).

[2]. Amir Masoud Rahmani ,"Machine Learning (ML) in Medicine: Review, Applications, and Challenges",Journal of Mathematics (2021).

[3] Christopher Toh and James P. Brody " Applications of Machine Learning in Healthcare",Web of science Book citation Jan (2021).

[4] Goodfellow D, Zhi R, Funke R, Pulido JC, Mataric M, Smith BA. Predicting Infant Motor Development Status using Day Long Movement Data from Wearable Sensors. arXiv preprint.; arXiv:1807.02617 (2018).

[5] Nagdev Amruthnath ," A Research Study on Unsupervised machine learning Algorithms for Early Fault detection in Predictive maintenance " , 5th International Conference on Industrial Engineering and Application (2018)

[6]. K.Shailaja .B.Seetharamulu ,"Machine learning in Healthcare:A Review",IEEE xplore 2018, Proceedings of the 2nd International conference on Electronics, Communication and Aerospace Technology (ICECA 2018) IEEE Conference Record # 42487; IEEE Xplore ISBN:978-1-5386-0965-1(2018).

[7] Demirhan, A. Neuroimage-based clinical prediction using machine learning tools. Int. J. Imaging Syst. Technol., 27, 89–97. 2017 Wiley Periodicals ,Incc (2018).

[8]. Datta, S.; Barua, R.; Das, J. Application of artificial intelligence in modern healthcare system. In Alginatesrecent Uses of This Natural Polymer; IntechOpen: Rijeka, Croatia, (2020).

[9] . Tijo & Abdulazeez , "Classification Based on Decision Tree Algorithm for Machine Learning", Journal of Applied Science and Technology Trends Vol. 02, No. 01, pp. 20 – 28, doi: 10.38094/jastt20165 (2021).

[10]. M. Usama et al.: Unsupervised Machine Learning for Networking: Techniques, Applications, and Research Challenges , Digital Object Identifier 10.1109/ACCESS.2916648,Publisher IEEE (2021).

[11] Arwinder Dhillon,"Machine Learning in Healthcare Data Analysis: A Survey", J. Biol. Today's World. Volume 8,Issue 6 (2019).

[12]. Syed K. Bashar,"Smartphone Based Human Activity Recognition with Feature Selection and Dense Neural Network", 978-1-7281-1990-8/20/$31.00 IEEE (2020).

[13] Jakaria Rabbi,"Human Activity Analysis and Recognition from Smartphones using Machine Learning Techniques",(2021)

[14] Senerath Mudalige Don Alexis Chinthaka Jayatilake," Involvement of Machine Learning Tools in Healthcare Decision Making", Hindawi Journal of Healthcare Engineering Volume 2021, Article ID 6679512, 20 pages https://doi.org/10.1155/2021/6679512 (2021).

[15] Olsen, C.R.; Mentz, R.J.; Anstrom, K.J.; Page, D.; Patel, P.A. Clinical applications of machine learning in the diagnosis, classification, and prediction of heart failure. Am. Heart J., 229, 1–17. (2020).

[16]. Tahmassebi A, Wengert GJ, Helbich TH, Bago-Horvath Z, Alaei S, Bartsch R, et al. Impact of machine learning with multiparametric magnetic resonance imaging of the breast for early prediction of response to neoadjuvant chemotherapy and survival outcomes in breast cancer patients. Invest Radiol.;54(2):110-117.(2019).

[17] Muhammad shoaib ," A Survey of Online Activity Recognition Using Mobile Phone",Sensors (2015).

[18]. Kayal CK, Bagchi S, Dhar D, Maitra T,Chatterjee S. Hepatocellular carcinoma survival prediction using deep neural network. Proceedings of International Ethical Hacking Conference.;349-358.(2019)

[19] F.H. Araújo, A.M. Santana, P.D.A.S. Neto, Using machine learning to support healthcare professionals in making preauthorisation decisions, Int. J. Med. Inf. 94 (2016) .

[20] S. Vyas, M. Gupta, R. Yadav, Converging blockchain and machine learning for healthcare, in: 2019 Amity International Conference on Artificial Intelligence (AICAI), IEEE, February, pp. 709–711(2019).

[21] Vladimir Nasteski , "An overview of the supervised machine learning methods", · December 2017 DOI: 10.20544/HORIZONS.B.04.1.17.P05(2017).

[22]. K. Butchi Raju, Suresh Dara, Ankit Vidyarthi, V. MNSSVKR Gupta, Baseem Khan, "Smart Heart Disease Prediction System with IoT and Fog Computing Sectors Enabled by Cascaded Deep Learning Model", Computational Intelligence and Neuroscience, vol. 2022, Article ID 1070697, 22 pages, (2022).

[23] E. Venkatesan et al., "Performance analysis of decision tree algorithms for breast cancer classification", Indian Journal of Science and Technology, vol.8, pp.1-8, (2015).

[24] L. P. Malasinghe et al ,"Remote patient monitoring: a comprehensive study", J Ambient Intell Human Comput 10:57–76 DOI 10.1007/s12652-017-0598-x (2019).

[25] H.K. Bharadwaj, A. Agarwal, V. Chamola, N.R. Lakkaniga, V. Hassija, M. Guizani, B. Sikdar, A review on the role of machine learning in enabling IoT based healthcare applications, IEEE Access 9 38859–38890. (2021).

[26] Christopher Toh,Applications of Machine Learning in Healthcare, Applications of Machine Learning in Healthcare DOI: http://dx.doi.org/10.5772/intechopen.92297,(2021)

[27] Yu-Jin Hong, Ig-Jae Kim, Sang Chul Ahn and Hyoung-Gon Kim "Activity Recognition using Wearable Sensors for Elder Care",(2008)

[28] S. J. Lewis et al "Artificial Intelligence in medical imaging practice: looking to the future" J Med Radiat Sci 66 292–295. (2019).

[29] Forum Desai. et .al ,"HealthCloud: A System for Monitoring Health Status of Heart Patients using Machine Learning and Cloud Computing"(2019).

[30] A. Sarirete et al.," Artificial intelligence and machine learning research: towards digital transformation at a global scale", Journal of Ambient Intelligence and Humanized Computing 13:3319–3321 https://doi.org/10.1007/s12652-021-03168 Springer (2022)

[31] M. Ferdous, J. Debnath, N.R. Chakraborty, Machine learning algorithms in healthcare: a literature survey, in: 11th International Conference on Computing, Communication and Networking Technologies (ICCCNT), IEEE, 2020, July, pp. 1–6. (2020).

[32] Z Chen et al “Robust human activity recognition using smartphone sensors via CT-PCA and online SVM”,IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS ,(2017).

[33]. S. Paraschiakos et al., “ Activity recognition using wearable sensors for tracking the elderly, User Modeling and User-Adapted Interaction 30:567–605 https://doi.org/10.1007/s11257-020-09268-2,Springer (2020).

[34] Muhammad Syafrudin, “Performance Analysis of IoT-Based Sensor, Big Data Processing, and Machine Learning Model for Real-Time Monitoring System in Automotive Manufacturing”, Sensors, 18, 2946; doi:10.3390/s18092946 (2018).

[35]. Iqbal H. Sarker1,”Machine Learning: Algorithms, Real-World Applications and Research Directions”, SN Computer Science 2:160 https://doi.org/10.1007/s42979-021-00592-x (2021).