Journal of Advanced Zoology

ISSN: 0253-7214

Volume ***44*** *Special Issue* ***-2 Year 2023*** *Page* ***3673:3686***

Predictive Data Analytics Framework Based on Heart Healthcare System (HHS) Using Machine Learning

Priya Mangesh Nerkar[1], Kazi Kutubuddin Sayyad Liyakat[2], Bhagyarekha Ujjwalganesh Dhaware[3], Kazi Sultanabanu Sayyad Liyakat[4]

[1]Sr. Research Associate, DL Solutions, Solapur. Maharashtra, India.
[2]Professor, Department of Electrical Engineering, Brahmdevdada Mane Institute of Technology, Solapur, Maharashtra, India.
[3]Assistant Professor, Department of Electronics and Telecommunication Engineering, Brahmdevdada Mane Institute of Technology, Solapur, Maharashtra, India.
[4]Research Associate, DL Solutions, Solapur. Maharashtra, India.

Email: [1]priyamnerkar@gmail.com, [2]drkkazi@gmail.com, [3]bhagyarekha.dhaware28@gmail.com, [4]rajasaheb.3617@gmail.com

Article History

Received: 06 June 2023

Revised: 09September 2023

Accepted:09 November 2023

Abstract

Cardiovascular diseases (CVD) have recently outdid all other reasons of death universal in both developing and developed nations. Initial detection of cardiac conditions and continuing therapeutic supervision by experts can lower the death rate. However, accurate diagnosis of cardiac issues in all circumstances and 24-hour patient consultation by a doctor are still not feasible due to the increased intellect, effort, and expertise required. In this study, a basic concept for an Machine Learning (ML)-based heart disease prediction system was presented to identify impending heart disease using Machine Learning techniques. Despite the increasing number of empirical studies in this topic, particularly from underdeveloped countries, here lack many synthesised research articles in the field. In a time when the amount of data available is constantly increasing, predictive analytics has become more and more important as a tool for heart welfare services and human protection. By utilising data collected from previous events to predict future patterns and outcomes, this state-of-the-art technology assists heart-care agencies in making more informed decisions about how to best serve their clients. However, as with any other data-driven technology, predictive analytics must be used appropriately to guarantee effective and ethical business operations. Healthcare forecasting has gained importance in recent years due to the growing popularity of AI (Artificial Intelligence) and ML (Machine Learning). In the healthcare sector, forecasting can also aid physicians in providing more precise and timely diagnoses. By anticipating likely medical events, medical staff can identify and treat individuals with greater efficiency and precision. This could lead to better patient outcomes and even cost savings. These systems provide excellent therapeutic support and have the ability to diagnose illnesses by mimicking human cognition. This study's included studies focus on forecasting the heart healthcare system (HHS) using machine learning algorithms. We implemented the

system using the K-means Elbow technique for registration and notification, a decision tree for HHS, and MySQL for immunisation reminders.

***Keywords**: Decision Tree, K-means algorithm, Machine Learning, MySQL, Hearth healthcare system(HHS), cardiovascular diseases,*

1. Introduction

Heart, a muscular tissue that pumps blood around the body, makes up the majority of the circulatory system of the body, which also includes the lungs. Another component of the cardiopulmonary system is the structure of blood vessels, including capillaries, arteries, and veins [1]. These blood vessels transport blood throughout the whole body. Changes in the heart's regular blood flow can result in a number of distinct heart ailments, which are collectively referred to as cardiovascular diseases (CVD). Heart conditions are among the main causes of mortality worldwide. WHO research indicates that cardiac arrests and strokes account for 17.5 million fatalities annually. Over 75% of CVD-related deaths take place in developing and developed countries. Furthermore, 80 percent of deaths due to CVD are caused by heart attacks and strokes [2]. As a result, a reduction in the death rate from CVD can be achieved by early detection of cardiac abnormalities and the creation of instruments for the prediction of heart disease. As a result of the development of sophisticated healthcare systems, a large number of patient data are already available (e.g. Big Data in Automated Health Record Systems), and these information bring used to produce prediction models for cardiovascular disorders. By examining vast volumes of data from many viewpoints, data mining and machine learning provide a technique to extract valuable information from them. Extraction of implicit, unrecognized, and potentially useful information from data is known as data mining [3]. The healthcare industry currently generates a huge amount of data about patients, illnesses, and other subjects.

Healthcare forecasting's predictive power comes from its ability to make predictions about impending medical events based on complex data correlations [4]. These data are gathered from a variety of sources, such as patient records, medical information, images, and more. Next, ML-Machine Learning and DL-Deep Learning algorithms are used to develop procedures for diagnosing and predicting illnesses. Medical professionals can more easily and quickly assess and treat conditions in patients thanks to these procedures [5, 6, 7].

In the field of healthcare, forecasting can also aid physicians in providing more precise and timely diagnoses. By anticipating likely medical events, medical staff can identify and treat patients more quickly and accurately. This could lead to improved patient outcomes and even cost savings [8]. In healthcare sector, forecasting can also reduce the risk of medical errors. By anticipating potential medical issues, healthcare professionals can take proactive measures to prevent them. This could lead to fewer medical errors and better patient care [9, 10].

The primary goal of predictive analytics is to identify patterns in current data and then use those patterns to project future events. In the context of heart-related welfare services, predictive analytics may be utilised to identify systemic issues that may be impacting heart protection measures. It could be applied, for example, to find racial disparities in the way the system treats particular families. By using predictive analytics to find these gaps and ensure that all families receive aid fairly and impartially, heart-welfare organisations can take action to close them [11].

Additionally, predictive analytics can be used to identify patients who may be at risk of abuse or neglect and intervene before things get out of control. By analysing data from previous cases, health-welfare organisations can more precisely identify which families might

be in danger and target those who need additional resources and support. This can ensure that the protective system is operating to its maximum capacity while ensuring those that require it a majority receive the help they need [12].

In this work, a predictive statistical analysis framework powered by machine learning and focused on the Heart Health Care System (HHS) is introduced. In order to improve the accuracy of heart care diagnosis and prognosis, the study looks into the possibility of using machine learning algorithms [13] to identify trends and patterns in medical data. The concept of analytical prediction is introduced in the article along with potential applications for the HHS. The research subsequently covers the various ML algorithms that can be used for predictive data analytics and looks into how each one is used [14]. After going over potential applications for analytical prediction in the HHS, the report concludes.

In summary, this research provides an extensive analysis of the potential for automated prediction to improve the accuracy of heart wellness examination and prognosis. We go into great detail about the data processing steps needed to prepare the data for analysis as well as the machine learning technique that is being used. The article also explores potential applications of analytics for forecasting within the HHS and offers recommendations for additional research. This study is a helpful resource for people who would like to in learning more about the potential applications of analytics for prediction in the HHS.

Literature Survey

A cardiac disease prognosis method utilising SEM and FCM was created by M Singh et al (2016). The info after the CCHS-2012 dataset has verified. Author(s) employed 20 significant characteristics. A SEM was utilized to generate the coefficient matrix utilized in the FCM model, which consequently predicted the potential for CVD. The correlation involving CCC 121 and 20 qualities forms a SEM model; in this case, CCC 121 was a factor that indicates if the responder has heart disease.

Bigdata was used by P Ghadge et al. (2016) to do research on an intelligent cardiac arrest prediction system. Although heart attacks become so frequent, it's critical to identify them as soon as possible. Finding an initial version of an intelligent heart attack prediction system which makes usage of bigdata and data mining modelling approaches was the major goal of this research study. This technology might extract undiscovered information on heart illness from a specific heart disease database.

Khan(2020) proposed Modified Deep CNN based IoT framework for accurately assessing cardiac ailments. For the purpose of continually tracking the electrocardiogram (ECG) and BP-blood pressure of patients, a cardiac monitoring device and smart watch were fastened to the patient. MDCNN was used to classify the collected sensor data into the abnormal and normal categories. Deep learning neural networks and other conventional procedures like logistic regression were used to analyse the created model. According to the experimental findings, the developed MDCNN achieved higher prediction performance for cardiac illnesses in terms of accuracy.

Lakshmi et al. (2019) developed a "IoT-enabled ECG monitoring system" to analyse the ECG data. To determine the dynamic characteristics, statistical features have been obtained and analysed using the "Pan Tompkins QRS detection" approach. The categorization step of forecasting the cardiac arrhythmia condition then made use of the "dynamic and statistical features". The analysis of heart ailment risk levels from ECG data has been the main focus of this model. For medical professionals to quickly and effectively assess cardiac disease, this paradigm proved helpful.

By Kazi (2022), whose investigates the health of COVID patients using IoT. Someone has to keep an eye on someone who has been placed under quarantine inside. To design a

ventilation system for those people, measures of human-body temperature, perspiration production, oxygen saturation, heart rate, respiration, and other factors are required. The body's temperature sensor looks for fever, the respiratory sensor tracks breathing, the cardiopulmonary sensor looks for heart attacks or chest pain, and the O2 sensor measures the body's O2 saturation levels. The suggested method, according to Kazi (2023), monitors saturating O2 levels, body temperature, pulse rate, and breathing rate. Information received is electronically transmitted to a neighbouring COVID medical centre or facility.

Wu et al.'s (2019) objective was to investigate the advantages of different DM techniques and validated models for cardiac disease survival prediction. Based on their observations, the authors theorised that DT and RF work best on smaller-dimensional datasets, while LR and NB perform better on large-dimensional samples like the Cleveland hospital dataset. Because RF uses a better learning methodology than the DT classifier, it performs better. The model could be constructed using tools like Map-Reduce, HBase, and other distributed computing technologies. As the author mentioned, more ML techniques may be added to this study in the future.

In order to distinguish between patients with mild-pneumonia-like illnesses and COVID-19 infections, the author's Gouda (2022) created the DL methodology, which offers a reliable technique for COVID-19 diagnosis. The suggested method used image-enhancing algorithms to improve the chest X-ray image and lower noise. This paper introduces two new deep learning techniques (DL) for COVID-19 detection using chest X-ray images. These techniques make use of a ResNet-50-like architecture to reduce overfitting and improve the overall performance of the proposed DL systems. As stated by the authors, evaluating the efficacy of the recommended approach requires the use of a large and challenging dataset containing several COVID-19 occurrences.

Machine Learning (Ml)

Machine learning is a form of artificial intelligence that enables computers to learn from data and make predictions about future outcomes [15]. It is a process of building algorithms that can learn from and make predictions on data. It is one of the most rapidly growing areas of computer science, and has been used to solve a variety of problems, from predicting stock prices to detecting fraud [16]. Machine learning models are built by extracting features from datasets, and using them to build an algorithm that can predict the output of a future event [17-20]. This process is called supervised learning, and involves training a model on existing data and then testing it on unseen data. In this way, machines are able to learn from existing data and make predictions about future events. The most common types of machine learning algorithms are supervised learning [21], unsupervised learning [22], and reinforcement learning [23]. Supervised learning is used when the data is labeled, meaning that it is known what the correct output should be, and the algorithm is trained on this data to produce a model that can make accurate predictions. Unsupervised learning is used when the data is unlabeled, meaning that the correct output is not known, and the algorithm is trained to identify patterns in the data that can be used to make predictions. Finally, reinforcement learning is used when the goal is to maximize a reward, such as in a game of chess. Machine learning algorithms are used in a wide variety of applications, from medical diagnosis to recommendation systems. The strength of machine learning lies in its ability to process large amounts of data, identify patterns, and make predictions. As more data becomes available and more sophisticated algorithms are developed, machine learning will continue to be an invaluable tool for solving complex problems [24, 25].

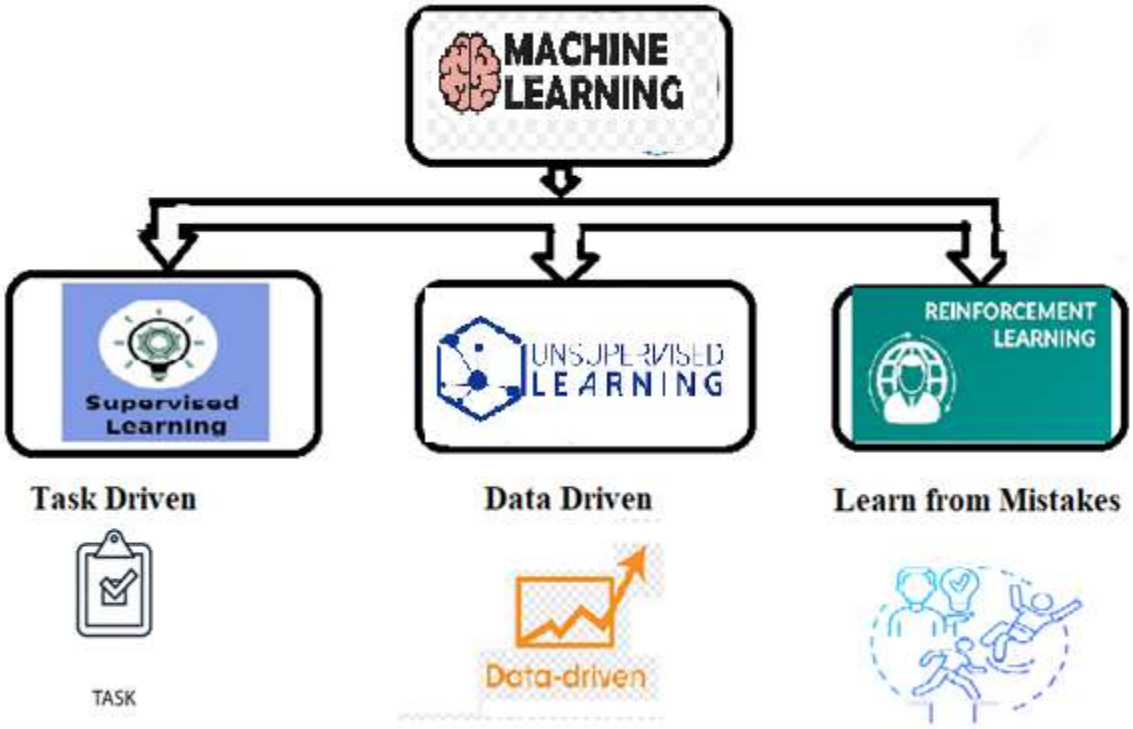

Figure 1- ML Types

Decision Trees

A decision tree is a powerful tool used to make decisions, classify data, and predict outcomes. It is a graphical representation of a decision process, and can be used to identify the best solution for a given problem. Decision trees are used in many fields, from business and economics to engineering and computer science [26-32]. Decision trees are built by breaking down a problem into a set of smaller, more manageable pieces. Each branch of the tree represents a decision or option for solving the problem. For example, if you had to decide whether to buy a car or a house, you might start by looking at the pros and cons of both options. You might then consider the cost of each option, the location, and the features of each option. This process of breaking down the problem into smaller pieces is known as 'branching [33-36]. At each branch of the tree, the data is evaluated to determine which option is best. For example, if the cost of the car is lower than the cost of a house, the decision tree might suggest that the car is the better option. If the cost is equal, the decision tree might suggest that location should be considered next [37-40]. Decision trees are used in many areas, including medical diagnosis, financial forecasting, and machine learning. In machine learning, decision trees are used to make predictions by analyzing a set of data and finding patterns. For example, a decision tree could be used to predict the likelihood that a customer will purchase a product based on past purchases. Decision trees are an important tool for problem solving, and can be used to make decisions quickly and accurately. They are easy to understand and interpret, and can be used to make predictions with high accuracy [41].

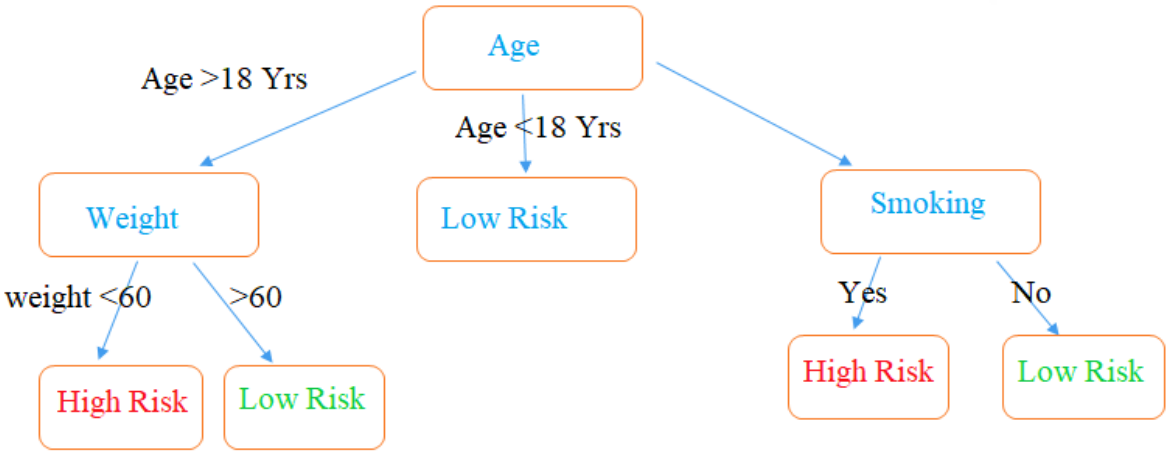

Figure 2- Decision Tree

K-Means Elbow Method

The K-Means Elbow Method is a popular and powerful data clustering technique used in unsupervised machine learning. It is used to identify the optimal number of clusters for a given data set. This method works by computing the sum of squared errors (SSE) for different values of k (number of clusters). The idea is to select the value of k where the SSE begins to diminish and the rate of decrease rapidly slows. This point is known as the "elbow" and the corresponding value of k is the optimal number of clusters for the data set[42]. The K-Means Elbow Method is an iterative process. The first step is to calculate the SSE for different values of k. This is done by randomly selecting k points from the data set and assigning them as initial cluster centers. Then, the remaining points are assigned to the closest cluster center. The SSE is then calculated by computing the distance between each point and its assigned cluster center. This process is repeated for different values of k and the SSE is calculated for each iteration[30,43]. The next step is to plot the SSE value against the number of clusters. This is known as the "elbow" plot. The optimal value of k is the value at which the SSE begins to decrease rapidly. In other words, the "elbow" in the plot is the point of greatest curvature and the corresponding value of k is the optimal number of clusters for the given data set[44]. The K-Means Elbow Method is a simple and effective technique for finding the optimal number of clusters for a given data set. It is easy to implement and can quickly identify the best number of clusters to use for any given data set. This makes it an invaluable tool for any data scientist.

MySQL

MySQL is an open source relational database management system (RDBMS) developed by Oracle Corporation. It is one of the most widely used database management systems in the world. MySQL is used to store, organize, and retrieve data from a variety of sources. It is used by web developers, web designers, IT professionals, and database administrators [32,45]. MySQL is a powerful and easy-to-use database system with a wide range of features. It provides a secure and reliable environment for storing large amounts of data and makes it easy to retrieve and manipulate data quickly and efficiently. MySQL is scalable and can be used for a wide range of applications, from small projects to large enterprise applications. MySQL is written in the C programming language and has many features such as triggers, stored procedures, and views. Its storage engine allows for storage of data in different formats [33, 46]. It provides support for a variety of data types, such as numeric, date, string, and binary. MySQL also provides support for transactions and replication, which makes it easier to maintain and manage data. MySQL is a popular choice for web development and is often

used in combination with web servers such as Apache and PHP. It is also used in a variety of other applications, such as content management systems, e-commerce systems, and financial applications. MySQL has a wide range of features and can be used to create complex databases and applications. It is a powerful and robust database system, and it is easy to learn and use. MySQL is a great choice for anyone looking for a reliable and powerful database system [34].

2. Methodology

A person's risk of contracting a disease is higher in younger people over the age of 18. 5.9 billion people die worldwide each year, and more than half of those deaths could have been prevented or treated earlier. Our investigation's findings regarding the dangers to heart health are presented in this report. Based on these findings, we created and executed an entirely new health risk management plan for BP patents [35]. Automating processes that need a medical diagnosis for people older than 18 is the aim of this system. The online portal system will identify possible health hazards and recommend preventative measures [36, 47]. The creation and implementation of a novel patient-centered online heart risk evaluation tool. Data about patients may be posted by guardians. In order to reduce health risks as soon as possible, the programme can evaluate current health and improvement status, identify harmful behaviours, anticipate potential cardiovascular diseases[37], provide health-related data (such as medication rates, coverage), and eventually offer tailored findings. Our research's objective is to:

• To lay the foundation for the user-reminder message programme for medications.
• To create a structure for giving care instructions on a monthly basis.

We build the system with Decision Trees to diagnose patients based on their reported symptoms and notify the doctor about the patient's condition for the patient's guardian. To build a framework to protecting them, we employ MySQL, and our system will send a message. This is accomplished by using MySQL. Figure 3 below shows the proposed prediction strategy for the heart healthcare sector.

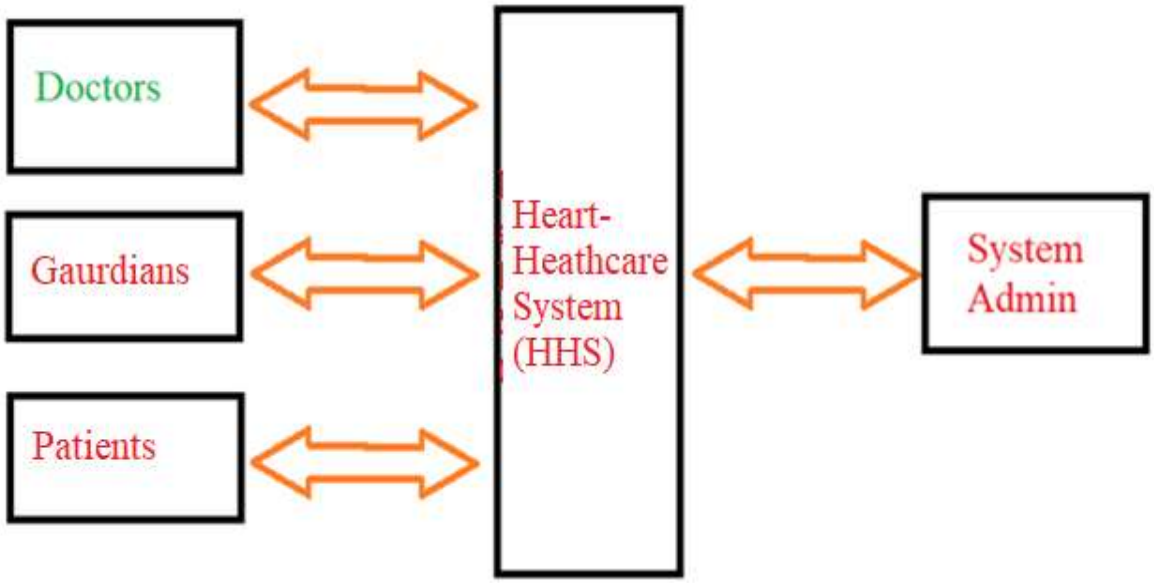

Figure 3- Proposed method

In this study, we employed the Decision Tree technique to further precisely predict, based on the patient's stated or determined symptoms, the duration of the patient's illness. In this dataset, the disease and its accompanying symptoms are represented by two nodes. The dataset is then trained and assessed by grouping all of the symptoms into a single row, activating the symptoms that correspond with the illness, then setting the value of the remaining symptoms to 1. This makes use of MySQL. A database management system is used to manage announcement details and registrations. Notifications are sent to registered end users via the SMS Integrating service. Figure 4 next shows the Heart-Healthcare System (HHS)[48] in action.

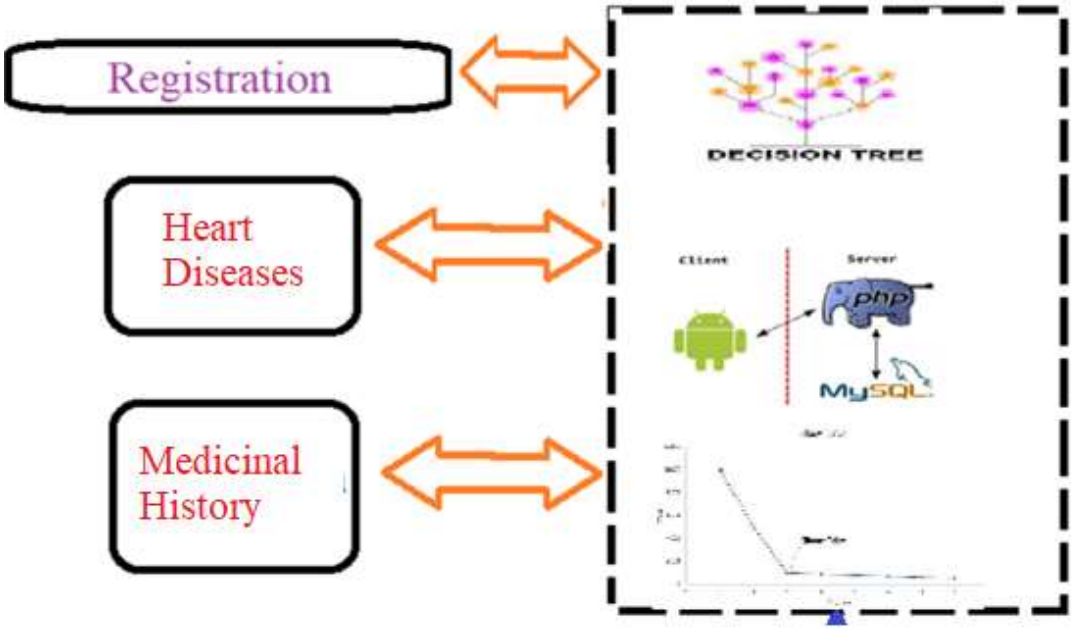

Figure 4- Heart-Healthcare system (HHS)

3. Results and Discussions

Patients or users need to sign up for the facility via details and submit basic data in order to receive father enhancement. During the registration process, basic information about the patient's blood pressure, habits, age, and medical history is gathered. This information includes a mobile number and is used to facilitate future communications and the provision of necessary data. In Figure 5, the registration screen is displayed.

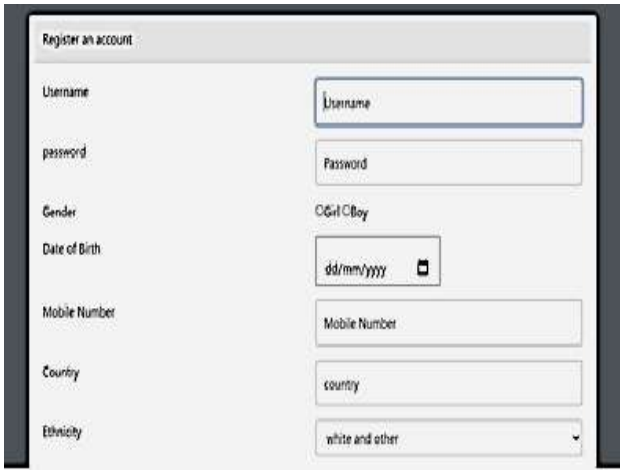

Figure 5 – MCHS registration procedure

Every enrolled patient is welcome to provide information about their symptoms in order to predict their illness. The system's patents require the screen of symptoms, which the ML-Decision Tree Algorithm analyses and provides the details of the illness along with the contact information of doctors who specialise in that field. We can see the information processing in Figures 6, 7, and 8.

Figure 6- Symptoms for HHS

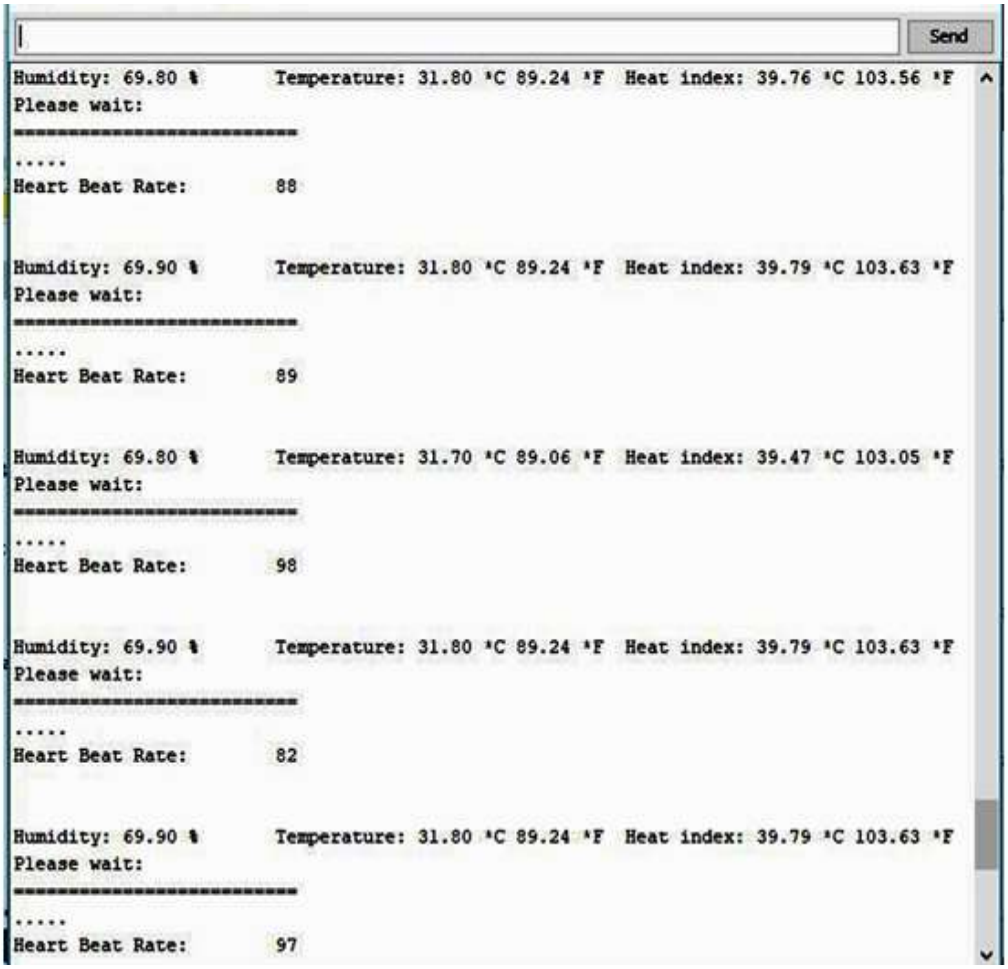

Figure 7 -Registered data

Figure 8- Information about illnesses and experts

Medication information is required for every patient up until the age of fifty in order to shield them from future dangers. Reminders for vaccinations are also sent to registered patients via the HHS system. Depending on the age given (DOB), the medical information is sent to the registered mobile devices of the guardian or patient.

After all the data has been entered into the system, the enrolled Candidates receive the diet plan. An example of a diet plan is shown in Figure 9 below. The approximate plan is depicted in the figure; physicians or dietitians have not verified it. This is only one diet example that we take into account. The shown weight is expressed in ponds.

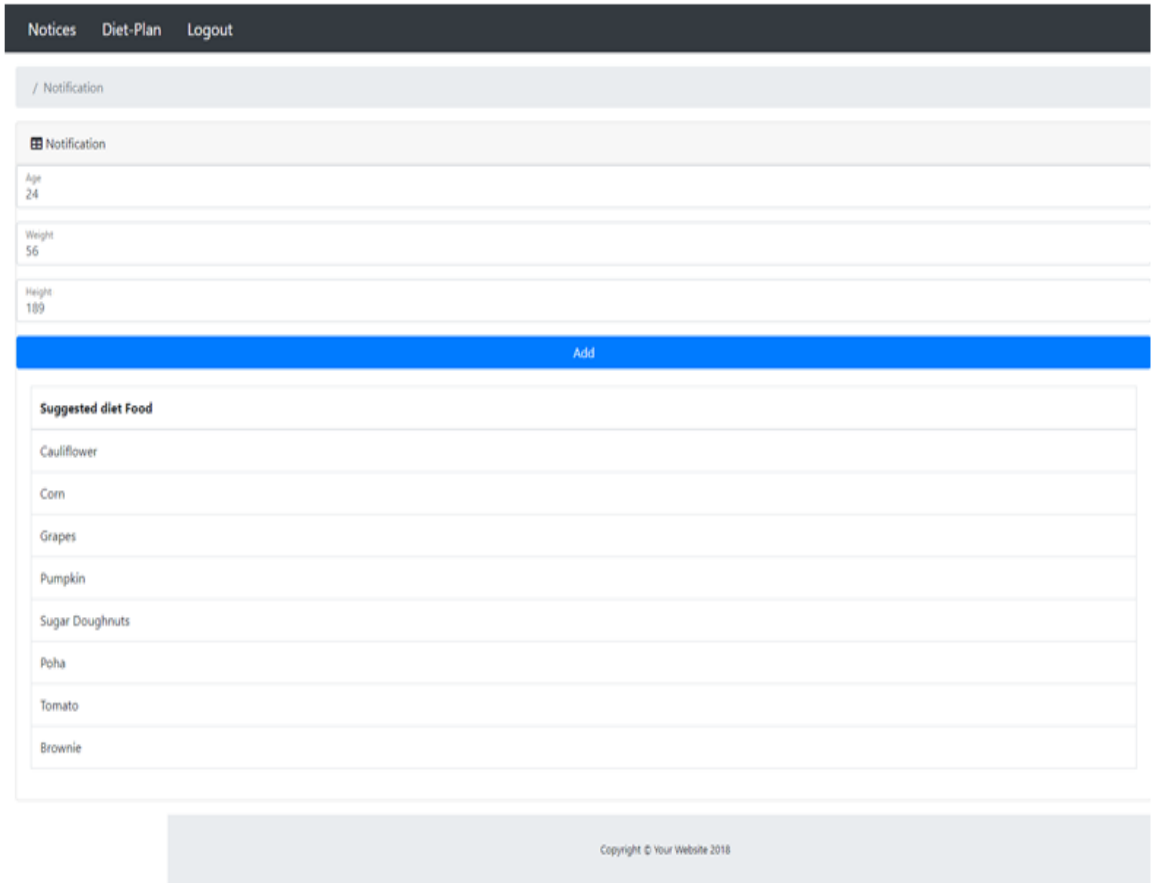

Figure 9- Diet plan notification

4. Conclusion

Robots can now perform crucial and time-consuming tasks in the medical field thanks to machine learning (ML), which is used in fields like medical imaging. These days, diseases and potential treatments are frequently identified using machine learning (ML). Healthcare data is thought to be the most important component that enters healthcare systems in terms of ML and DL usage. Machine learning (ML) holds great promise for improving the efficiency and ease of medical treatment and care processes. It can also improve the accuracy of predictions made by ML algorithms, which can help doctors make decisions more quickly. The possibility is comparable to current medical subfields and healthcare applications. The Heart-Healthcare (HHS) systems' data analytics architecture was created by us by determining the severity using the data submitted during registration as well as timely update information. We also offer information regarding medications. Along with providing them with a meal plan and activities, we also use the aforementioned system to support their wellbeing and provide information about health issues. We implemented the system using a decision tree for health services, MySQL for immunisation reminders, and the K-means Elbow method for registration and notification.

5. References

1. M Sunil Kumar, D Ganesh, Anil V Turukmane, Umamaheswararao Batta, ,"Deep Convolution Neural Network based solution for detecting plant Diseases", Journal of Pharmaceutical Negative Results, 2022, Vol 13, Special Issue- I, pp. 464-471,
2. Ms. Shweta Nagare, et al., "Different Segmentation Techniques for brain tumor detection: A Survey", MM- International society for green, Sustainable Engineering and Management, 2014, Vol 1, issue 14, pp.29 - 35.
3. Ms. Shweta Nagare, et al., "An Efficient Algorithm brain tumor detection based on Segmentation and Thresholding", Journal of Management in Manufacturing and services, 2015, Vol 2, issue 17, pp.19 - 27.
4. Madhupriya Sagar Kamuni, et al, "Fruit Quality Detection using Thermometer", Journal of Image Processing and Intelligent Remote Sensing, 2022, Vol 2, Issue 5.
5. Shweta Kumtole, et al, " Automatic wall painting robot Automatic wall painting robot", Journal of Image Processing and Intelligent remote sensing, 2022, Vol 2, issue 6
6. K. Kazi, "Systematic Survey on Alzheimer (AD) Diseases Detection", 2022
7. Miss. Priyanka M Tadlagi, et al, "Depression Detection", Journal of Mental Health Issues and Behavior (JHMIB), 2022, Vol 2, Issue 6, pp. 1 - 7
8. Waghmare Maithili, et al, "Smart watch system", International journal of information Technology and computer engineering (IJITC), 2022, Vol 2, issue 6, pp. 1 - 9.
9. Liyakat, K.K.S. (2023). Machine Learning Approach Using Artificial Neural Networks to Detect Malicious Nodes in IoT Networks. In: Shukla, P.K., Mittal, H., Engelbrecht, A. (eds) Computer Vision and Robotics. CVR 2023. Algorithms for Intelligent Systems. Springer, Singapore. https://doi.org/10.1007/978-981-99-4577-1_3
10. Singh, M., Martins, L.M., Joanis, P. and Mago, V.K. (2016) Building a Cardiovascular Disease Predictive Model Using Structural Equation Model and Fuzzy Cognitive Map. IEEE International Conference on Fuzzy Systems (FUZZ), Vancouver, 24-29 July 2016, 1377-1382
11. Ghadge, P., Girme, V., Kokane, K. and Deshmukh, P. (2016) Intelligent Heart Attack Prediction System Using Big Data. International Journal of Recent Research in Mathematics Computer Science and Information Technology, 2, 73-77
12. M. A. Khan, "An IoT framework for heart disease prediction based on MDCNN classifier," IEEE Access, vol. 8, pp. 34717–34727, 2020.

13. K. K., "Multiple object Detection and Classification using sparsity regularized Pruning on Low quality Image/ video with Kalman Filter Methodology (Literature review)", 2022
14. R. Lakshmi Devi and V. Kalaivani, "Machine learning and IoT-based cardiac arrhythmia diagnosis using statistical and dynamic features of ECG," The Journal of Supercomputing, vol. 76, no. 9, pp. 6533–6544, 2019.
15. Miss. A. J. Dixit, et al, "A Review paper on Iris Recognition", Journal GSD International society for green, Sustainable Engineering and Management, 2014, Vol 1, issue 14, pp. 71 - 81.
16. Miss. A. J. Dixit, et al, "Iris Recognition by Daugman's Algorithm – an Efficient Approach", Journal of applied Research and Social Sciences, 2015, Vol 2, issue 14, pp. 1 - 4.
17. K. Kazi, "A Review paper Alzheimer", 2022
18. Kazi K S, "IoT-Based Healthcare Monitoring for COVID-19 Home Quarantined Patients", Recent Trends in Sensor Research & Technology, 2022, Vol 9, Issue 3. pp. 26 – 32
19. Kazi K S, "IoT based Healthcare system for Home Quarantine People", Journal of Instrumentation and Innovation sciences, 2023, Vol 8, Issue 1, pp. 1- 8
20. Wu CS, Badshah M, Bhagwat V. Heart disease prediction using data mining techniques. In Proceedings of the 2019 2nd international conference on data science and information technology 2019 Jul 19 (pp.7–11)
21. Gouda W, Almurafeh M, Humayun M, Jhanjhi NZ. Detection of COVID-19 Based on Chest X-rays Using Deep Learning. In Healthcare 2022 Feb 10 (Vol.10, No. 2, p.343). MDPI.
22. Kazi K S L, "Significance of Projection and Rotation of Image in Color Matching for High-Quality Panoramic Images used for Aquatic study", International Journal of Aquatic Science, 2018, Vol 09, Issue 02, pp. 130 – 145.
23. Kazi K S, " Detection of Malicious Nodes in IoT Networks based on Throughput and ML", Journal of Electrical and Power System Engineering, 2023, Volume-9, Issue 1, pp. 22- 29.
24. Prof. Vinay S , et al, "Multiple object detection and classification based on Pruning using YOLO", Lambart Publications, 2022, ISBN – 978-93-91265-44-1
25. K K S. L., "Predict the Severity of Diabetes cases, using K-Means and Decision Tree Approach", Journal of Advances in Shell Programming, 2022, Vol 9, Issue 2, pp. 24-31
26. Sultanabanu Kazi, Mardanali Shaikh, Kazi Kutubuddin "Machine Learning in the Production Process Control of Metal Melting" Journal of Advancement in Machines, Volume 8 Issue 2 (2023)
27. K. Kazi, "Smart Grid energy saving technique using Machine Learning" Journal of Instrumentation Technology and Innovations, 2022, Vol 12, Issue 3, pp. 1 – 10.
28. M Pradeepa, et al, "Student Health Detection using a Machine Learning Approach and IoT", 2022 IEEE 2nd Mysore sub section International Conference (MysuruCon), 2022.
29. Dr. A. O. Mulani, "Effect of Rotation and Projection on Real time Hand Gesture Recognition system for Human Computer Interaction", Journal of The Gujrat Research Society, 2019, Vol 21, issue 16, pp. 3710 – 3718
30. Ms. Machha Babitha, C Sushma, et al, "Trends of Artificial Intelligence for online exams in education", International journal of Early Childhood special Education, 2022, Vol 14, Issue 01, pp. 2457-2463.
31. Dr. J. Sirisha Devi, Mr. B. Sreedhar, et al, "A path towards child-centric Artificial Intelligence based Education", International Journal of Early Childhood special Education, 2022, Vol 14, Issue 03, pp. 9915-9922.

32. Mr. D. Sreenivasulu, Dr. J. Sirishadevi, et al, "Implementation of Latest machine learning approaches for students Grade Prediction", International Journal of Early Childhood special Education, 2022, Vol 14, Issue 03, pp. 9887-9894.
33. Dr. K. P. Pardeshi et al, "Development of Machine Learning based Epileptic Seizureprediction using Web of Things (WoT)" , NeuroQuantology, 2022, Vol 20, Issue 8, pp. 9394- 9409
34. Dr. K. P. Pardeshi et al, "Implementation of Fault Detection Framework for Healthcare Monitoring System Using IoT, Sensors in Wireless Environment", Telematique, 2022, Vol 21, Issue 1, pp. 5451 - 5460
35. Ravi A. , et al, "Pattern Recognition- An Approach towards Machine Learning", Lambert Publications, 2022, ISBN- 978-93-91265-58-8
36. Gouse Mohiuddin Kosgiker, "Machine Learning- Based System, Food Quality Inspection and Grading in Food industry", International Journal of Food and Nutritional Sciences, 2018, Vol 11, Issue 10, pp. 723- 730
37. K. K. S. Liyakat, "Detecting Malicious Nodes in IoT Networks Using Machine Learning and Artificial Neural Networks," 2023 International Conference on Emerging Smart Computing and Informatics (ESCI), Pune, India, 2023, pp. 1-5, doi: 10.1109/ESCI56872.2023.10099544.
38. Vahida Kazi, et al, " Deep Learning, YOLO and RFID based smart Billing Handcart", Journal of Communication Engineering & Systems, 2023, 13(1), pp. 1-8
39. Karale Aishwarya A, et al, "Smart Billing Cart Using RFID, YOLO and Deep Learning for Mall Administration", International Journal of Instrumentation and Innovation Sciences, 2023, Vol 8, Issue- 2.
40. Kazi Kutubuddin Sayyad Liyakat, "IoT based Smart HealthCare Monitoring", In: Rhituraj Saikia (eds), Liberation of Creativity: Navigating New Frontiers in Multidisciplinary Research, Vol. 2, July 2023, pp. 456- 477, ISBN: 979-8852143600
41. Kazi Kutubuddin Sayyad Liyakat, "IoT based Substation Health Monitoring", In: Rhituraj Saikia (eds), Magnification of Research: Advanced Research in Social Sciences and Humanities, Volume 2, October 2023, pp. 160 – 171, ISBN: 979-8864297803
42. Sultanabanu Kazi, et al.(2023). Fruit Grading, Disease Detection, and an Image Processing Strategy, Journal of Image Processing and Artificial Intelligence, 9(2), 17-34.
43. Priya Mangesh Nerkar1 , Sunita Sunil Shinde, et al, "Monitoring Fresh Fruit and Food Using Iot and Machine Learning to Improve Food Safety and Quality", Tuijin Jishu/Journal of Propulsion Technology, Vol. 44, No. 3, (2023) , pp. 2927 – 2931 https://propulsiontechjournal.com/index.php/journal/article/view/914
44. Priya M Ravale, et al, "Retinal Image decomposition using Variational mode decomposition", International Research Journal of Engineering and Technology, 2018, Vol 5, Issue 6.
45. Altaf Osman Mulani, Rajesh Maharudra Patil "Discriminative Appearance Model For Robust Online Multiple Target Tracking", Telematique, 2023, Vol 22, Issue 1, pp. 24-43
46. Priya Ravale, "FPGA based finger vein recognition system for Personal verification", International Journal of Engineering, Research and General Science, 2015, Vol 3, Issue 4.
47. Kazi Kutubuddin S. L., "Business Mode and Product Life Cycle to Improve Marketing in Healthcare Units", E-Commerce for future & Trends, 2022, vol 9, issue 3, pp. 1-9.

48. Waghmare Maithili, et al, "Smart watch system", International journal of information Technology and computer engineering (IJITC), 2022, Vol 2, issue 6, pp. 1 – 9, [online] available at: http://hmjournals.com/journal/index.php/IJITC/article/view/1138/1295