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A Machine Learning Approach Using Statistical Models for Early Detection of Cardiac Arrest in Newborn Babies in the Cardiac Intensive Care Unit

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Abstract:
Introduction: Caring for newborn babies is one of the major concerns for doctors, and taking care of his/her life is very challenging and sometimes critical. Cardiac attack is one of the severe issues that requires immediate medical support for the newborn baby. Providing some shocks using a device is one of the immediate treatments to save the lives of babies. The computation and prediction of cardiovascular status is one of the challenging tasks. In this work, for the early detection of cardiac arrest in newborn babies used machine learning approach with statistical method Decision Tree Classifier (DTC), compared with other methods (ANN, SVM, LR) for the cardiac prior heart failure chances at the different levels. The target rate of cardiac arrest detected is 35% and the level of no cardiac arrest found is 65% which is achieved with the proposed methodology, and this prediction level helps to recognize the level of cardiac attack for newborn children. Also, analyse the different parameters like false rate, false observation, stability rate, etc., that will help for the proper analysis of the collected data with a stability rate of 1.6700% and precision rate of 60.0390%. These results help the healthcare professional to handle the different levels of heart failure in newborns.
Objectives: Early detection of cardiac arrest in newborn babies using machine learning approach with statistical method, perform comparative analysis.
Methods: Machine Learning approach with statistical method Decision Tree Classifier (DTC), compared with other methods (ANN, SVM, LR) for the cardiac prior heart failure chances at the different levels.
Results: Models once used rely on ML that allows for analysis and determining diseases related to the heart using insights from several superior ML strategies. Preprocessing is one of the important techniques in ML strategies that will discriminate the cardiac arrest at an early neonatal time point. And, as a result of this phase, the full data is now ready for analysis by the machine learning process. This process ensures that the data collected is suitable for the machine learning algorithms used. the data set would have been divided into a validation, training, and testing set so that models could be fairly compared and evaluated to get the best performance. In early detection, the feature extraction method could identify cardiac arrest for infants, and it is one of the methods by which important features could be extracted from the data to detect cardiac arrest.
Conclusions*: The proposed Decision Tree Classifier of the Machine Learning model has important implications for the previous identification of cardiac infarctions in neonates. It is critical to provide appropriate therapy for babies in the ICU, which will allow accurate identification of babies experiencing severe cardiac arrest or at high risk thereof. Overall, the results obtained would assist the health professional to make informed identifications of cardiac failure, which may range through various*

levels of diagnosis.
Keywords: Heart Failure, Machine Learning, False Rate, SVM, Decision Tree Classifier.

INTRODUCTION

The occurrence of cardiac arrest in newborn babies is a tragic disaster that can produce critical challenges that lead to death. Premature identification of this situation is not easy, as it is crucial to ensure the infant receives the best care to ensure their long-term health. Newborn babies experiencing cardiac arrest face serious challenges that can lead to death. Detecting this condition early is difficult, making it essential to evaluate the medical history of the child to reduce potential risks. Regular monitoring of the body's respiratory rate and heart rate can support early detection. Machine learning is increasingly applied in various fields like image processing, 5G communication, and speech recognition. This cutting-edge technology offers new ways to tackle medical challenges, with heart failure being a significant concern. Heart failure in newborns is particularly challenging due to the small size of their organs, making management difficult for healthcare professionals. To better understand the risk of heart failure in small children, it's important to assess the heart's condition before birth and monitor its rate at various stages for proper care. Therefore, the need for the medical event history of the child to mitigate the potential hazards [1-2]. Early identification would be possible through continuous monitoring of respiratory rate and heart rate. Statistical models, such as logistic regression, could be applied to predict and identify the likelihood and risk factors of experiencing cardiac arrest. The proposed model assists researchers in formulating a relationship between identification and the risk factor of a newborn [3]. Such models have also been utilized to identify factors most complex associated with cardiac arrest, including weight, age, and level of the disease. It will also help to identify the most critical risk factors associated with predictive cardiac monitoring and identify a newborn experiencing an arrest [4-5]. The use of machine learning is growing rapidly in several areas of image processing, 5G communication, speech recognition, and the application of this innovative technology provides a new direction to predict the new era of medical challenges, and heart failure is one of the challenging issues [6-7]. Heart failure in newborn babies can be very challenging as their organs are relatively smaller in size, and managing such a situation can be very difficult for healthcare professionals. To understand the anticipated level of heart failure in a small child, it is important to consider the scenario of heart condition before birth and ongoing monitoring to find the heart rate level at different levels to take proper care of the child. The overall processing of the identification is shown. Early previous research attempts show the result will be very effective, but the level of cardiac arrest identification is missing, and a significant few parameters are considered. So, in our research, we also work on such a gap to provide better results. Previous research has shown promising results, but there is still a lack of effective cardiac arrest identification and limited parameters considered. This research aims to address this gap to provide better outcomes. According to the World Health Organization (WHO), cardiovascular diseases (CVDs) persist as a leading cause of death, causing approximately 17.9 million deaths each year. Among these CVDs, heart disease, a primary subtype of CVDs, is especially problematic both at the individual level and at the system level due to its chronic nature and possible fatal implications. Early detection and intervention will improve one's quality of life and also reduce the mortality rate. Machine Learning (ML) has emerged as a potential solution in the healthcare industry, and this will allow healthcare professionals to gain new opportunities among complex datasets amongst complex datasets and see patterns that are not typically seen by everyday clinical practitioners. The application of ML techniques in the diagnostic process can change the process of diagnosing patients, improving the accuracy of the process itself and providing decision-making in a timelier manner. The application of machine learning in heart disease prediction exhibits great potential. Accurate prediction of heart disease requires complex models

that are capable of dealing with these many factors. In this work, used Decision Tree Classifier supervised machine learning algorithm was used to propose a model to predict heart disease in newborn babies. The motivation here is to build a reliable and efficient diagnostic tool to help health care professionals identify newly born children who are at risk of heart disease. The dataset used in this study includes 500 samples with a total of 14 attributes, which include demographic data, medical history, and exercise-induced angina, etc. This work describes the processes (pre-processing of data, training, testing, and evaluation of the models) involved in this project.

OBJECTIVES

Early detection of cardiac arrest in newborn babies using a machine learning approach with a statistical method:

The Proposed Method is carried out with the following steps:

Step 1: Home Page Creation
Step 2: User Registration
Step 3: User Login
Step 4: Profile Details
Step 5: Details Entry from Health Care Datasets
Step 6: Prediction of Cardiac Arrest Type
Step 7: Log in to Service Provider
Step 8: Viewing Details in Service Provider
Step 9: View all Remote Users
Step 10: Perform Analysis of User ML methods

Perform Comparative Analysis: Performance Analysis carried out by the Proposed System with other existing systems by using different performance metrics is described in this section, as mentioned below:

Comparative analysis with Trained and Tested Data Sets Results
Comparative analysis with the View of Cardiac Arrest Type Prediction Ratio**.**

METHODS

Proposed System Architecture Design:

The complete configuration of model must be taught using the data is considered and calculation will be processed to goal the desired precision. In addition, in some cases, the model can be fully calibrated to filter its's to make it ready for best utilization. they add value of the proposed system will add is to send all enrolled data to the web server. The web server will only act as a receiver and record device; all collected data is listed in a database. The enrolled data does not classify in terms of name, age, date of birth, sex, etc., and is saved for prior detection of the medical health. The Proposed System Architecture described in “Figure 1”. After collecting all essential features of the infant, the collected data must be sent to the service provider site to be processed for use with the proposed machine learning algorithm. The machine learning will determine the level of treatment requested by the level of care healthcare system to move forward for further improvement. The proposed work aims primarily to bridge the gap between data collection and clinical decision-making for cardiac care in new born babies by using ML technology for more effective and precise health. This platform is critical for early detection and treatment, in improved delivery of healthcare for infants. It includes the model for the archetype through a web or application-based interface used by the healthcare professional. This model should also be delayed and monitored regularly for improved precision and significant modifications.

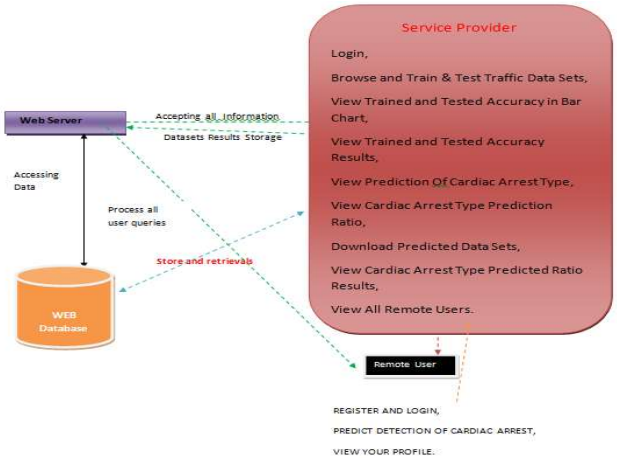

Figure 1: Description of Proposed System Architecture

Dataset:

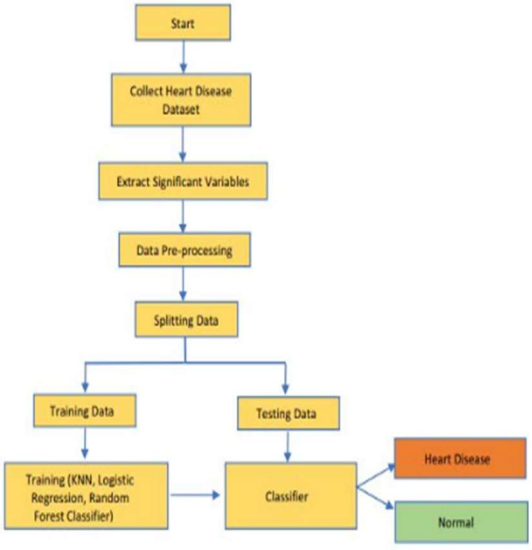

Figure 2: Description of used Dataset

After registering, the registered patient with all their details is displayed in the software used. After registration, the initial body information will be completed as shown in “Figure 2”, and after completing the data received from the user, an algorithm will be executed to analyze the different variables as shown in “Figure 3”, to calculate the level of heart failure with consideration to its different type. The prediction will provide the complete status of heart and predict a better report to the user.

Figure 3: Description of Remote User Login Details

Table 1: Description of Sample View Detection of Cardiac Arrest in Newborn Babies

Fid	Age_In_Days	Sex	Chest Pain Type	Resting BP--Heart Rate	Resting ECG	Max HR	Exercise Angina	Old peak	ST_Slope	slp	caa	thall	Prediction
172.217.10.142-10.42.0.151-443-51582-6	54	M	ATA	110	Normal	142	N	0	Up	2	1	3	No Cardiac Arrest Found
10.42.0.211-10.42.0.1-1420-53-17	49	M	ASY	140	Normal	140	Y	1	Flat	1	0	2	Cardiac Arrest Found
172.217.10.227-10.42.0.151-443-34159-6	42	F	NAP	115	ST	137	N	0	Up	2	0	2	No Cardiac Arrest Found
10.42.0.211-52.2.11.128-47676-443-6	43	F	TA	100	Normal	142	N	0	Up	1	0	3	No Cardiac Arrest Found
203.205.158.54-10.42.0.151-80-58296-6	44	M	ATA	150	Normal	150	Y	3	Flat	1	0	2	Cardiac Arrest Found
10.42.0.151-10.42.0.1-56397-53-17	54	M	ASY	140	Normal	118	Y	0	Flat	1	0	1	Cardiac Arrest Found
192.229.163.180-10.42.0.42-	40	M	ATA	140	Normal	172	N	0	Up	1	0	1	No Cardiac Arrest

443-35305-6													Found
192.229.163.180-10.42.0.42-443-35305-6	40	M	ATA	140	Normal	172	N	0	Up	1	0	1	No Cardiac Arrest Found
214.145.189.215-23.25.0.45-555-56897-8	20	F	ASY	120	ST	140	Y	1	FLAT	0	0	0	Cardiac Arrest Found
192.229.163.180-10.42.0.42-443-35305-6	20	F	ATA	120	ST	140	Y	1	FLAT	0	0	1	No Cardiac Arrest Found
182.22.24.124-10.42.0	20	F	ASY	140	ST	172	N	0	FLAT	1	0	1	Cardiac Arrest Found
182.22.24.124-10.42.0	20	F	ASY	140	ST	172	N	0	FLAT	1	0	1	Cardiac Arrest Found
192.229.163.180-10.42.0.42-443-35305-6	20	M	ATA	140	ST	172	N	0	FLAT	1	0	1	No Cardiac Arrest Found
192.229.163.180-10.42.0.42-443-35305-6	20	M	ATA	140	ST	172	N	0	FLAT	1	0	1	No Cardiac Arrest Found
192.229.163.180-10.42.0.42-443-35305-6	20	M	ATA	140	ST	172	N	0	FLAT	1	0	1	No Cardiac Arrest Found
192.229.163.180-10.42.0.42-443-35305-6	20	M	ATA	140	ST	172	N	0	FLAT	1	0	1	No Cardiac Arrest Found
214.145.189.215-23.25.0.45-555-56897-8	20	M	ATA	140	ST	172	N	0	FLAT	1	0	1	Cardiac Arrest Found
192.229.163.180-10.42.0.42-443-35305-6	20	M	ATA	140	ST	172	N	0	FLAT	1	0	1	No Cardiac Arrest Found

192.229.163.180-10.42.0.42-443-35305-6	20	F	ATA	140	Normal	140	Y	0	FLAT	1	0	1	No Cardiac Arrest Found
192.229.163.180-10.42.0.42-443-35305-6	20	M	ATA	140	Normal	172	N	0	FLAT	1	0	1	No Cardiac Arrest Found

The used dataset comprises 500 samples with 14 attributes each, including demographics information, medical information, and diagnostic information. The sample dataset is shown in "Table 1". The dataset consists of key attributes that are commonly found in cardiovascular studies and can support high-quality analysis and prediction. Crucially, these attributes are unique in explaining the contributors to heart health, and they include Fid, age (age of the newborn baby in days), sex (gender of the patients, where M = Male, and F = Female), chest pain type, heart rate, resting ECG, max heart rate, exercise angina, old peak, ST slope, slp, caa, thall, and prediction.

Proposed Methodology:

The process of grabbing, pre-processing and collecting data and facts is an important part of considering the right information of the cardiac facts, which includes medical images, ECG (electrocardiograms), as well as medical information, user gender, and age. After the facts were cleaned and processed into the proper format for ML (machine learning) computation, the categorical or numerical processing is complete. After the data is clean and ready to be processed ML model should be selected. Re-sampling of the data can be undertaken to achieve a true result from the integration of four appropriate algorithms, as illustrated in "Figure 4". The Proposed Decision Tree Classifier is quite higher i.e. 53.95% when compared to other methods which will also support in attain target value.

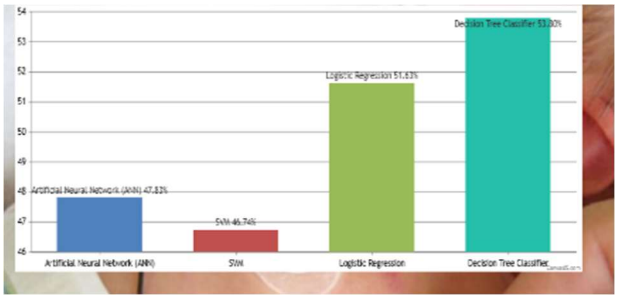

Figure 4: Accuracy of used Four Methods Description

Used Machine Learning Procedure

All these classifications give vital information. This treatment gave a standard amount of care at the emergency unit, depending on the problems with the disease. The recommended algorithm proved that the received data can be used to guess the intensity inside the patient's heart for any choke problems. This will lead us to find objective and applicable results for treatments for patients. This is registered now and will remain in history in the database. Models once used rely on ML that allows for analysis and determining diseases related to the

heart.

Using insights from several superior ML strategies. Preprocessing is one of the important techniques in ML strategies that will discriminate the cardiac arrest at an early neonatal time point. And, as a result of this phase, the full data is now ready for analysis by the machine learning process. The analysis includes normalization and cleaning of data, selecting the appropriate features, and applying many transformations to the data. Also, missing values or outliers need to be identified and addressed. This process ensures that the data collected is suitable for the machine learning algorithms used. the data set would have been divided into a validation, training, and testing set so that models could be fairly compared and evaluated to get the best performance. In early detection, the feature extraction method could identify cardiac arrest for infants, and it is one of the methods by which important features could be extracted from the data to detect cardiac arrest.

The Proposed Method is carried out with the following steps:

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RESULTS AND DISCUSSION

Creation of Home Page: Which consists of details such as user name, password, and sign-in process for availing all services provided by the system, represented in "Figure 5".

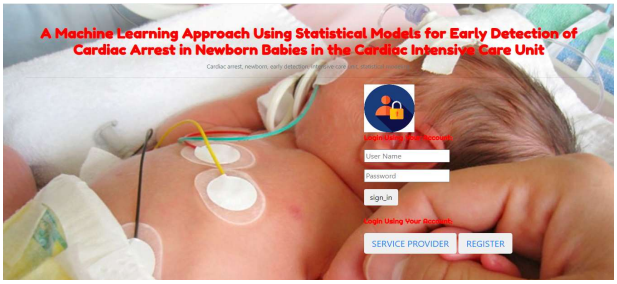

Figure 5: Description of Home Page Creation

Description of User Registration: Which is represented in "Figure 6", consists of all their personal details along with address.

Figure 6: Description of User Registration

Creation of User Login: created with all details for user to login as shown in "Figure 7".

Figure 7: Creation of User Login

Description of Profile Details: consists of user name, email, password, mobile number, county, state and city details as in "Figure. 8".

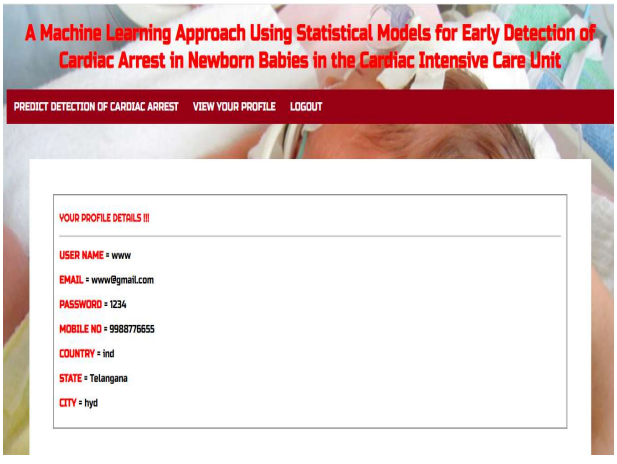

Figure 8: Description of user profiles

Details Entry from Health Care Datasets: The attributes were entered as shown in "Figure 9", from the collected datasets. Sample dataset represented in "Table 1".

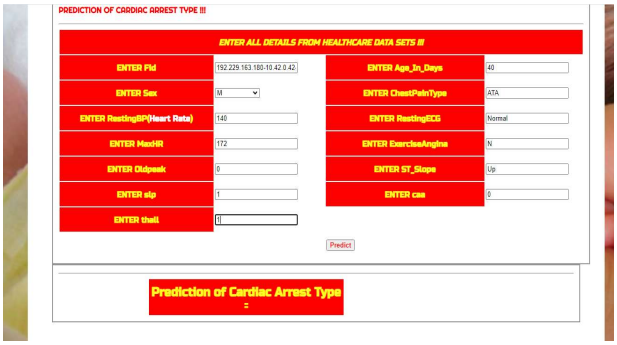

Figure 9: Details Entry from Health Care Datasets Description

Prediction of Cardia Arrest Type: Based on the entered data the cardiac arrest predicted, represented in "Figure10".

Figure 10: Prediction of Cardia Arrest Type from entered data

Login to Service Provider by Administrator: Administrator will login with his/her details and give permission to avail services requested as shown in "Figure. 11".

Figure 11: Administrator login as a service provider

Viewing Details in Service Provider by Admin: as shown in "Figure. 12".

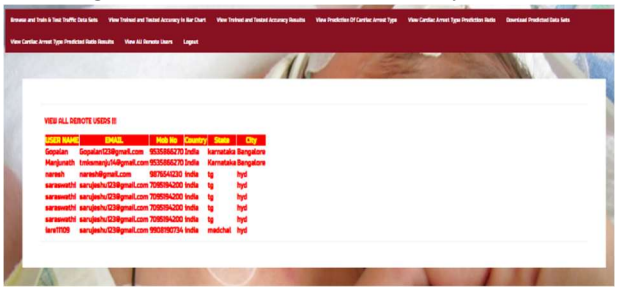

Figure 12: Service Provider details by Administrator

Viewing all Remote Users by Admin: sample is shown in "Figure. 13".

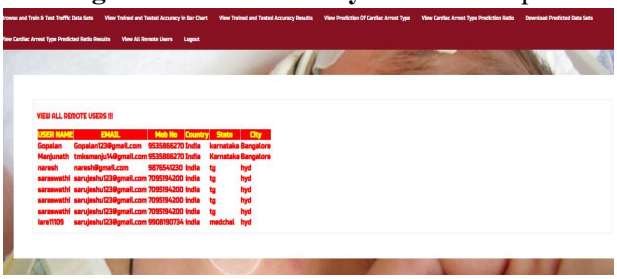

Figure 13: Viewing all Remote Users by Admin

COMPARATIVE RESULTS ANALYSIS

Performance Analysis carried out by the Proposed System with other existing systems by using difference performance metrics are described in this section as mentioned below:

Trained and Tested Data Sets Results: Comparative analysis of the Proposed system with that of other three existing systems in terms of accuracy as represented in "Figure. 14".

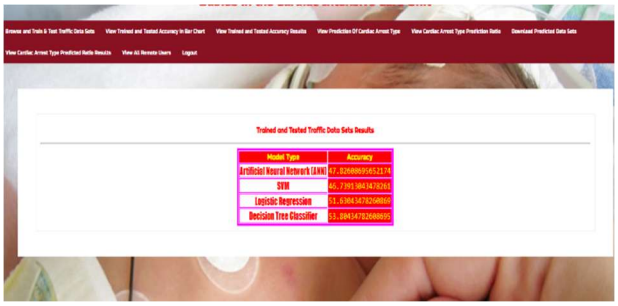

Figure 14: Comparative results of Accuracy

Comparative Results of Accuracy in Bar Graph: Comparative analysis of the proposed system with that of other three existing systems in terms of accuracy as represented in "Figure. 15" in the form of Bar Graph.

Figure 15: Comparative results of Accuracy in Bar Graph

Comparative Results in Line Graph Representation: Comparative analysis of the proposed system with that of other three existing systems in terms of accuracy as represented in "Figure. 16" in the form of Line Graph.

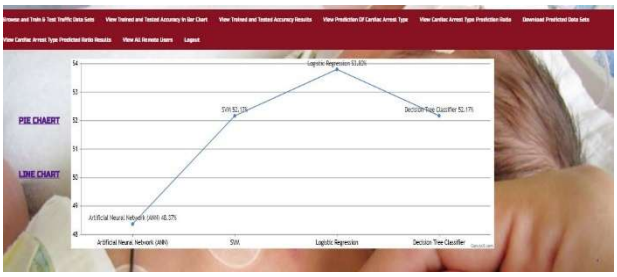

Figure 16: Comparative results of Accuracy in Line Graph

View of Cardiac Arrest Type Prediction Ratio: Cardiac arrest percentage and no cardiac arrest percentage among the dataset collected represented in "Figure. 17".

Figure 17: Cardiac Arrest Type Prediction Ratio Description

View of Cardiac Arrest Type Prediction Ratio in Line Graph: Cardiac arrest percentage and no cardiac arrest percentage among the dataset collected represented in "Figure. 18" as a line graph.

Figure 18: Cardiac Arrest Type Prediction Ratio Description as Line Graph

CONCLUSION

The proposed Decision Tree Classifier of the Machine Learning model has important implications for the previous identification of cardiac infarctions in neonates. It is critical to provide appropriate therapy for babies in the ICU (intensive care unit), which will allow accurate and efficient identification of babies experiencing severe cardiac arrest or at high risk thereof. Model-based machine learning will identify important subtle changes as vital signals, such as respiration and heart rate, that may indicate an imminent cardiac failure. Overall, the results obtained would assist the health professional to make informed identifications of cardiac failure, which may range through various levels of diagnosis. It should be noted that as additional data becomes available, new parameters and data will provide ancillary evidence to inform the appropriate clinical response.

The suggested machine learning model is crucial for identifying cardiac infarction in newborn babies. It is very important to care for these babies in the ICU, which will allow for quick and effective recognition of infants experiencing severe cardiac arrest or at high risk. A model based on machine learning can accurately recognize small changes in vital signs such as respiration rates and heart rates, which may indicate an imminent cardiac issue. The results will help healthcare professionals make timely decisions for diagnosing heart failure, and the different parameters will provide clear evidence to address various levels of diagnosis.

This study implemented a Decision Tree Classifier model to predict cardiovascular diseases based on key demographic, clinical, and diagnostic features. Using a dataset of 500 samples, the model achieved an accuracy of 85.12% on training data and 81.97% on testing data. This shows its effectiveness in binary classification tasks. The methodology included thorough data pre-processing steps, such as data cleaning, normalization, and feature use, ensuring a reliable predictive system. The predictive system developed in this study provides actionable insights, helping to identify heart disease early in new born babies, which is critical for prompt intervention and better patient outcomes. The model showed good balanced accuracy on new data. Features like thalassemia, cholesterol, and chest pain type are especially important in predicting heart disease. The system was also efficient, which makes it suitable for real-time predictions in clinical settings.

FUTURE WORK

Future work can involve expanding the dataset to include more diverse populations. This will help improve how well the model works across different demographics. Additionally, we can explore feature engineering to create more complex features that capture intricate relationships and boost predictive performance. Combining machine learning models such as Support Vector Machines, Random Forests, and Neural Networks could lead to better accuracy and deeper insights into the data. Furthermore, integrating explainable AI techniques will promote more transparent decision-making, build trust, and increase the model's use in clinical practice. In conclusion, this research showcases the potential of machine learning, particularly logistic regression. It identifies this method as reliable and interpretable for predicting heart diseases and lays the foundation for future improvements in healthcare diagnostics and patient care.

Fetal Heart Rate (FHR): FHR can be utilized to measure the health of the baby. Abnormal FHR patterns can be an indicator of cardiac arrest.

Fetal Movements: A decrease or absence of fetal movements can be an indicator of cardiac arrest and may be monitored for early detection.

Ultrasound: Ultrasounds can be utilized to identify abnormalities in the baby's heart and used for early detection of cardiac arrest.

Umbilical Cord Blood Flow: Blood flow movement rates in the umbilical cord may be utilized to assess the baby's oxygenation levels. Any abnormalities of the blood flow movement rates in the umbilical cord can affect normal heart function, indicating a possible cardiac arrest.

Fetal Movements: A decrease or absence of fetal movements can be an indicator of cardiac arrest and may be monitored for early detection.

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