IJASRM

International Journal of Advanced Scientific Research and Management, Volume 8 Issue 9, Sept 2023

www.ijasrm.com

ISSN 2455-6378

A Survey of Healthcare monitoring for cardiovascular diseases using IoT

Vetrimanikumar.J[1], Dr.S.Karthigai Lakshmi[2]

[1] Department of ECE, /SSM Institute of Engineering and Technology, Dindigul, Tamilnadu 624002, India

[2] Department of ECE, /SSM Institute of Engineering and Technology, Dindigul, Tamilnadu 624002, India

Abstract

Healthcare is one of the most rapidly expanding application areas of the Internet of Things (IoT) technology .The impact of the Internet of Things (IoT) on the advancement of the healthcare industry is immense. IoT devices can be used to enable remote health monitoring of patients with chronic diseases such as cardiovascular diseases. The Objective is to propose a monitoring system that can send patients physical signs to remote medical applications in real time and to develop protocols in the healthcare IoT scenario in terms of computation time and security to show its suitability and robustness. The proposed Hybrid algorithm is meant for classification in the field of Healthcare especially cardiovascular disease, To create a secure data transmission environment between IoT devices and Patients as patients data are sensitive. To create a low power consumption environment. To predict forecasting future outcomes and results for the patients about their Cardiovascular health issues.

Keywords: *Internet-of-Things(IoT),Hybrid algorithm*

1. Introduction

Cardiovascular sicknesses (CVDs) are a set of disorders of the coronary heart and blood vessels. They consist of: Coronary heart ailment – a disorder of the blood vessels imparting the heart muscle; Cerebrovascular ailment - a disorder of the blood vessels supplying the brain;Peripheral arterial disorder – a sickness of blood vessels offering the arms and legs; Rheumatic coronary heart disease – damage to the coronary heart muscle and heart valves from rheumatic fever, resulting from streptococcal bacteria. congenital coronary heart disorder – birth defects that affect the ordinary development and functioning of the heart resulting from malformations of the heart shape from beginning and deep vein thrombosis and pulmonary embolism – blood clots in the leg veins, that may dislodge and pass to the coronary heart and lungs. Heart assaults and strokes are commonly acute occasions and are particularly because of a blockage that forestalls blood from flowing to the coronary heart or mind. The most common cause for that is a build-up of fatty deposits at the inner partitions of the blood vessels that supply the heart or brain. Strokes can be as a result of bleeding from a blood vessel within the brain from blood clots. Most cardiovascular illnesses can be avoided by addressing behavioral risk factors such as tobacco use, poor diet and obesity, physical inactivity, and excessive alcohol consumption. It is critical to recognize cardiovascular illness as early as possible in order to begin treatment with counseling and medications

1.1 Causes of CVD

Often, there are not any signs of the underlying disease of the blood vessels. A heart assault or stroke can be the primary sign of underlying disease. signs and symptoms of a heart attack encompass: Pain or discomfort inside the centre of the chest; and/or Ache or pain within the fingers, the left shoulder, elbows, jaw, or lower back. Similarly the man or woman can also enjoy trouble in respiration or shortness of breath; nausea or vomiting; mild-headedness or faintness; a chilly sweat; and turning light. girls are more likely than guys to have shortness of breath, nausea, vomiting, and lower back or jaw pain.

The maximum not unusual symptom of a stroke is unexpected weakness of the face, arm, or leg, most usually on one facet of the frame. other signs consist of sudden onset of:

Numbness of the face, arm, or leg, especially on one aspect of the body Confusion, issue speak me or information speech,Problem seeing with one or each eyes, Problem taking

https://doi.org/10.36282/IJASRM/8.9.2023.1903

International Journal of Advanced Scientific Research and Management, Volume 8 Issue 9, Sept 2023

IJASRM

www.ijasrm.com

ISSN 2455-6378

walks,dizziness,Extreme headache without a recognized purpose,Fainting or unconsciousness.

1.2 Remedial measures

The important thing to cardiovascular ailment discount lies in the inclusion of cardiovascular ailment management interventions in commonplace health insurance packages; although in a high number of countries fitness systems require substantial funding and reorientation to efficiently manipulate CVDs.Proof from 18 countries has proven that high blood pressure programmes can be implemented efficaciously and value-successfully at the primary care level with a purpose to ultimately bring about reduced coronary heart ailment and stroke. Sufferers with cardiovascular ailment should have get entry to suitable era and medicinal drug. Primary drugs that need to be to be had include: Aspirin;Beta-blockers; Angiotensin-converting enzyme inhibitorsStatins.An acute event inclusive of a heart assault or stroke ought to be directly managed. From time to time, surgical operations are required to treat CVDs. They consist of: Coronary artery skip; Balloon angioplasty (wherein a small balloon-like device is threaded via an artery to open the blockage); Valve repair and alternative; Heart transplantation; and Synthetic heart operations. Medical devices are required to deal with some CVDs. Such gadgets consist of pacemakers, prosthetic valves, and patches for closing holes within the coronary heart.

1.3 Applications of IoT

The Internet of Things (IoT) is a group of "things" having electronics, software, sensors, actuators, and other components and linked through the Internet to exchange information with one another. The IoT devices' sensors and computing power enable their deployment in a variety of settings. The smart home, smart city, smart grids, medical and healthcare equipment, connected automobiles, and other common IoT applications are shown in Figure 1.

According to a 2013 research by the International Data Corporation (IDC), the rapidly increasing number of IoT devices in use is expected to reach 41 billion in 2020 with a $8.9 trillion market .

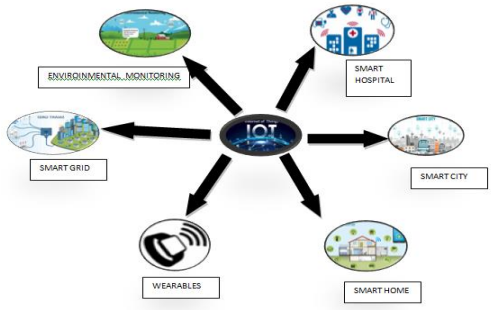

Figure 1. Applications of IoT

The absence of a human component distinguishes the Internet of Things from the conventional Internet. IoT devices have the ability to gather data on people's behaviour, analyze it, and take appropriate action . Although the services offered by IoT apps are very beneficial to people, they can be very expensive when it comes to protecting people's and privacy.

1.4 Machine Learning algorithms

In the area of cardiovascular illnesses, machine learning algorithms have shown considerable potential in aiding in early detection,
diagnosis, risk prediction, and therapy planning. Here are a few typical machine learning techniques for applications and research in cardiovascular disease:

1. Logistic Regression: This technique is frequently used for binary classification tasks, including determining whether or not a patient has a specific cardiovascular disease based on a variety of risk variables.
2. Random Forest: The ensemble learning method Random Forest combines various decision trees to provide predictions. It is helpful in addressing non-linear relationships and feature selection, and it may be applied to both classification and regression problems.
3. Support Vector Machines (SVM): SVM is a potent classification method that is successful in classifying data, making it practical for using patient data to identify particular cardiovascular problems.
4. Neural Networks: Deep learning models, particularly Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), have achieved outstanding results in the detection and classification of cardiovascular disease using image-based analysis (echocardiograms, MRIs), time-series data (e.g., electrocardiograms), and other types of data.
5. Gradient Boosting Algorithms: Two examples of gradient boosting algorithms that excel in both classification and regression tasks are XGBoost and LightGBM. These algorithms offer precise predictions and feature importance analyses.
6. Decision Trees: Used for classification, decision trees can handle both category and numerical data. They are useful for acquiring insights into the decision-making process since they can be interpreted.
7. Naive Bayes: Naive Bayes is a probabilistic technique for classification applications that performs well with sparse data.
8. K-Nearest Neighbors (KNN): KNN is a straightforward and understandable method that relies on the similarity between data points when performing classification jobs.
9. Long Short-Term Memory (LSTM): An RNN variant that is good at interpreting sequential data,

https://doi.org/10.36282/IJASRM/8.9.2023.1903

such as time-series data from heart monitoring, is LSTM.

10. Gaussian Processes: These probabilistic models, which also include estimates of uncertainty, are helpful for predicting risks for specific individuals.

2. Related Works

In the work of [1],The patient's heart illness is predicted using the HOBDBNN algorithm, which has a 99.03% accuracy rate. Utilizing the MATLAB simulation program, efficiency is assessed.

IoT assisted ECG monitoring framework[2] with Light weight control,Light weight secure IoT for data transmission is used to determine healthcare. The Health information of the patients is send to the edge server, the datas are encrypted.the cloud server maintains the data of patients, the doctor after authentication gets decrypted data from the cloud server. G. Rajkumar et.al[3] suggests an improved framework for heart disease prediction based on deep learning. The solution uses the general publicly accessible Hungarian heart illness dataset, which contains information on heart disease that was gathered from patients using IoT sensor devices. To resolve missing values and incorrect data, the input dataset is pre-processed using the median studentized residual method. By using the Harris Hawk Optimization (HHO) technique, features from pre-processed data values are chosen. modified Deep Long Short-Term Memory (MDLSTM) then divides the chosen attributes into normal and abnormal categories. Using the Improved Spotted Hyena Optimization (ISHO) technique, the LSTM output is modified. Results are implemented using parameters including specificity, sensitivity, F-Score, Kappa value, accuracy, BER, and execution time in the Python working platform. In comparison to other methods currently in use, the implemented approach has an accuracy rate of 98.01% and a lower error rate of 91.11, according to the results of the analysis. In the work of [4], Patients can access early diagnosis, consultations, and disease management using telecardiology during prime time. Without protection, sending ECG data to a cardiologist could lead to a wrong diagnosis. In this study, a brand-new technique for sending safe ECG data to cardiologists for clinical care has been put forth. First, pre-processed ECG datasets are collected from the MIT-BIH database. Low-frequency noise has been removed using the Savitzky-Golay (SG) filter, and high-frequency noise has been removed using the maximal overlap wavelet packet transform (MOWPT), then features have been extracted. The water cycle optimization (WCO) technique is used for authentication, and the triple data encryption standard (3-DES) has been applied for encryption. The ECG data is subsequently sent to a cardiologist via the internet of things (IoT) platform ThingSpeak, encrypted and authorized. Avalanche effect is 50.12%, mean square error is 0.463, number of pixels change rate (NPCR) is 100, unified averaged changed intensity (UACI) is 39.698, and execution time is 0.003 msec. These numbers represent the performance of the suggested approach. In comparison to the current methods, the significance of the suggested strategy offers minimum error with faster processing times, better values of avalanche effect, NCPR, and UACI. In the work of [5], Automated physiological signal monitoring for elderly unwell patients allows for quick data availability as well as dependable service through correct forecasting by the healthcare provider. This research focuses on an innovative Internet of Things (IoT) application-based physiological signal monitoring system to enhance the e-healthcare system in order to overcome this difficulty. A precise signal prediction and estimate approach based on deep neural networks was used to implement the suggested system. Using National Instrument myRIO for intelligent data capture and an intelligent sensor from National Instrument for signal measurement, the suggested system is prototyped as an advanced electronics component. As a consumer device, Smart-Monitor is made with sophisticated sensors. Four physiological signal prediction accuracies for two users were computed to verify the proposed Smart-Monitor system. In an experimental prototype setup, an A 97.2% average accuracy was attained. This demonstrates the dependability of the suggested automated system and the feasibility of accurate monitoring. We confirm the suggested system's ability to deliver dependable assistance and precise signal prediction based on the experimental findings.

Uma N.Dulhare [6] suggests Heart disease is a leading cause of death worldwide. Data mining is crucial in the health care business because it allows health systems to effectively use data and analytics to discover problems, which improves care while lowering costs. A classification technique is one of the data mining techniques. For each case in the data, supervised learning is utilised to accurately forecast the target class. Cardiovascular disease Classification entails distinguishing between healthy and unhealthy people. The linear classifier is a Naive Bayes (NB) classifier. In terms of modest variations or changes in training data, it is relatively stable. Swarm of Particles Optimization (PSO) is a fast evolutionary computation technique that finds the best solution .aspects that contribute more to the output, reducing calculation time and increasing the experimental results suggest that the proposed model using PSO as feature selection improves The Naive Bayes classifier's prediction performance in classifying heart disease with accuracy of 87.91%.

In the work of [7],The Internet of Things (IoT) has had a massive impact on the growth of the healthcare business. both at the hardware and underlying software levels. This goal has resulted in the creation of Healthcare IoT (H-IoT) solutions.

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ISSN 2455-6378

Table -1: Comparison of previous works

Author	algorithm	evaluation criteria	accuracy
Sina Dami et.al.	LSTM neural network,deep belief network	Accuracy, Precision, F-Measure	88.42 %
S. Mohan et.al.	HRFLM	Accuracy, Sensitivity, Precision,Specificity,F-Measure	88.7%
Parasuraman Kumar et.al.	Artificial Bee Colony Optimization (ABCO)	execution time, system efficiency	92.5%
Mohammad Ayoub Khan et.al.	Modified deep Convolutional Neural Network(MD CNN)	Accuracy, Disease prevalence, Precision, Positive predictive value,Negative predictive value,Sensitivity, Recall, Specificity, F1 Score	98.2%

The essential enabling technologies include communication systems between sensing nodes and processors, as well as processing algorithms for generating an output from sensor data.
However, various new technologies are currently supporting these enabling technologies.

Fig -2: Healthcare sensors

The application of Artificial Intelligence (AI) has changed H-IoT systems at nearly every level. The fog/edge concept brings processing power closer to the deployed network, hence minimising several issues. While big data provides for the handling of massive amounts of data. Furthermore, Software Defined Networks (SDNs) add flexibility to the system, while blockchains discover the most unique use cases in H-IoT systems. The Internet of Nano Things (IoNT) and Tactile Internet (TI) are driving H-IoT application innovation. In the work of [8],This article investigates how these technologies are reshaping H-IoT systems, as well as the future path for increasing Quality of Service (QoS) using these new technologies. The development of arterial and cardiovascular events, which leads in heart failure and early mortality in the form of myocardial infarction, stroke, and fainting, is now one of the major causes of death worldwide. As a result, it is critical to alert people prior to disasters occurring in order to prevent and warn of aberrant conditions. A deep learning strategy was utilised in this work to predict arterial events over a few weeks/months prior to the occurrence utilising a 5-min electrocardiogram (ECG) recording and extracting time-frequency aspects of ECG signals. The Long Short-Term Memory (LSTM) neural network was utilised to consider the prospect of learning long-term dependencies in order to recognise and prevent these events as fast as feasible. To represent and choose more efficient and effective characteristics of the recorded dataset, a Deep Belief Network (DBN) was also utilised. This method is abbreviated as LSTM-DBN. The proposed approach was evaluated using four publicly available datasets in the field of health care. In the context of the Internet of Things, this data were acquired from wearable heart rate monitoring sensors as well as demographic information. The proposed LSTM-DBN prediction results were compared to those of various deep learning systems (simple RNN, GRU, CNN, and Ensemble) and classical classification algorithms (MLP, SVM, Logistic Regression, and Random Forest). Furthermore, DBN performance was compared to that of other feature selection and representation approaches, such as PCA and AutoEncoder. The experimental findings revealed that the suggested LSTM-DBN (88.42% mean accuracy) performed much better than all other deep learning algorithms and traditional classifications.
T. Alladi [9] proposed that A large amount of patient data is being communicated and made available online as a result of the recent application of IoT in the field of healthcare. This involves the implementation of adequate security measures to prevent cyberattacks. Several authentication mechanisms have been developed recently to solve these difficulties, but the physical security of healthcare IoT devices against node tampering and

https://doi.org/10.36282/IJASRM/8.9.2023.1903

node replacement threats, in particular, is not adequately addressed in the literature. To solve these issues, this work presents a two-way two-stage authentication protocol based on hardware security primitives known as Physical Unclonable Functions (PUFs). Given the memory and energy limits of healthcare IoT devices, this protocol is designed to be very light. To demonstrate the protocol's validity, a rigorous security examination is performed. In terms of computing speed and security.

S.Mohan[10] suggests Heart disease is one of the leading causes of death in the globe today. Cardiovascular disease prediction is a key difficulty in clinical data analysis. Machine learning has been demonstrated to be helpful in assisting in decision making and prediction from the huge amount of data generated by the healthcare business. Machine learning (ML) techniques have also been employed in recent breakthroughs in several domains of the Internet of Things (IoT). a novel strategy for identifying key features using machine learning techniques, which will improve the accuracy of cardiovascular disease prediction.

3. Conclusions

IoT based health monitoring provides solutions to the patients suffering from cardiovascular diseases.CVD can be caused due to lifestyle or due to heredity,behavioural factors,metabolic factors,Environmental factors, accuracy and representativeness of the training data have a significant impact on the algorithm's success. Additionally, the performance of the algorithm may be considerably impacted by additional elements including feature engineering, data pre-treatment, and model tweaking. To discover the optimum model for the particular cardiovascular disease prediction problem at hand, it is crucial to experiment with several algorithms and adjust their parameters. The prediction model is introduced with many feature combinations and several well-known classification approaches.

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