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An Impact of Healthcare Using IOT Heart

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Abstract:

Heart health monitoring has become essential in modern healthcare because of the rising number of heart diseases and sudden cardiac emergencies. Many heart conditions develop without noticeable symptoms. Traditional healthcare mainly relies on periodic checkups or visits initiated by patients. This may not catch early warning signs in time. In this situation, Internet of Things (IoT) devices are crucial for continuous heart monitoring. Wearable IoT devices, such as smartwatches, come with sensors that can track heart rate and identify irregular pulse patterns in real time. The collected data is automatically sent to mobile applications or cloud platforms for analysis and long-term monitoring. When the system detects abnormal heart activity, it can quickly alert the patient, caregivers, or healthcare professionals, allowing for timely medical intervention. This IoT-based method enables remote healthcare, lowers emergency risks, and encourages preventive and personalised heart care. It also enhances overall healthcare efficiency and patient safety.

INTRODUCTION:

Cardiovascular diseases (CVDs) are a significant and widespread health issue worldwide. They are a leading cause of death in both rich and poor countries. These diseases include conditions like heart attacks, coronary artery disease, arrhythmia, and high blood pressure. Many cardiovascular disorders develop gradually and often show no early symptoms. This makes timely diagnosis challenging. Because of this silent progression, patients may not seek medical help when they should, which can lead to serious complications or sudden cardiac events.

Traditional healthcare systems mostly rely on hospital visits, regular checkups, and symptoms reported by patients. This approach is reactive and does not provide continuous monitoring of a patient's heart condition. As a result, early warning signs of heart problems are frequently overlooked. To overcome these issues, Internet of Things (IoT) technology has emerged as a promising solution in healthcare.

IoT in healthcare allows the use of smart, connected devices to gather and share health data in real time. Wearable IoT devices, like smartwatches, play an important role in monitoring heart health by continuously tracking vital signs such as heart rate and pulse rhythm. These devices have sensors that collect physiological data and send it to mobile apps or cloud platforms for storage and analysis. If abnormal heart activity is detected, the system can quickly send alerts to patients, caregivers, or healthcare professionals, allowing for timely medical intervention.

This project aims to develop an IoT-based heart monitoring system using a wearable watch to improve early detection of cardiovascular issues. By enabling continuous monitoring, remote healthcare support, and preventive care, the proposed system aims to lower health risks, improve patient outcomes, and boost the overall efficiency of healthcare services.

RELATED WORK:

Several researchers have looked into IoT-enabled healthcare systems for detecting heart disease by pairing wearable sensors with machine learning and deep learning methods. Earlier studies mainly used traditional machine learning algorithms like K-Nearest Neighbour (KNN), Naïve Bayes, Decision Tree (DT), Random Forest (RF), and Support Vector Machine (SVM) to classify heart diseases using ECG and clinical datasets. These methods achieved moderate to high accuracy; however, their performance often relied on manual feature extraction and struggled with continuous time-series ECG data, which is vital for real-time heart monitoring.

More recent studies introduced deep learning methods, especially Convolutional Neural Networks (CNN), to automatically extract spatial features from ECG signals. CNN-based models improved classification accuracy for arrhythmia and myocardial infarction detection when tested on standard datasets such as UCI, MIT-BIH, and PhysioNet. However, CNN models tend to focus on spatial patterns and do not capture long-term temporal dependencies in heartbeat signals effectively. This limits their ability toanalysee changes in ECG data over time.

To address these issues, some studies used Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM) models for predicting heart disease. LSTM networks are suitable for time-series data because they can keep long-term dependencies and learn patterns from ECG signals and heart rate variability. Research shows that LSTM-based models perform better in detecting arrhythmias and abnormal heart conditions compared to traditional machine learning techniques, especially in continuous monitoring situations.

Hybrid deep learning models that combine CNN and LSTM have recently attracted interest in IoT-based cardiac healthcare systems. In these models, CNN layers automatically extract features from ECG signals, while LSTM layers analyse the timing relationships between successive heartbeats. Compared to standalone CNN or LSTM models, hybrid CNN-LSTM architectures show higher accuracy, more robustness, and better real-time prediction capability. These models work especially well for wearable IoT systems, where constant data streams and quick alerts are essential.

Compared to prior studies that mainly depend on traditional classifiers or single deep learning models, the proposed approach uses LSTM and hybrid CNN-LSTM algorithms to improve temporal learning, reduce false alarms, and aid proactive healthcare monitoring. This makes the new system more suitable for real-time IoT-based heart health applications, offering better diagnostic accuracy and timely medical intervention.

MATERIAL AND METHOD:

This section describes the materials used and the method for developing an IoT-based heart health monitoring system with LSTM and hybrid CNN-LSTM algorithms. The proposed framework supports real-time monitoring, early detection of heart problems, and timely medical decision-making through smart data analysis.

A. Data Collection

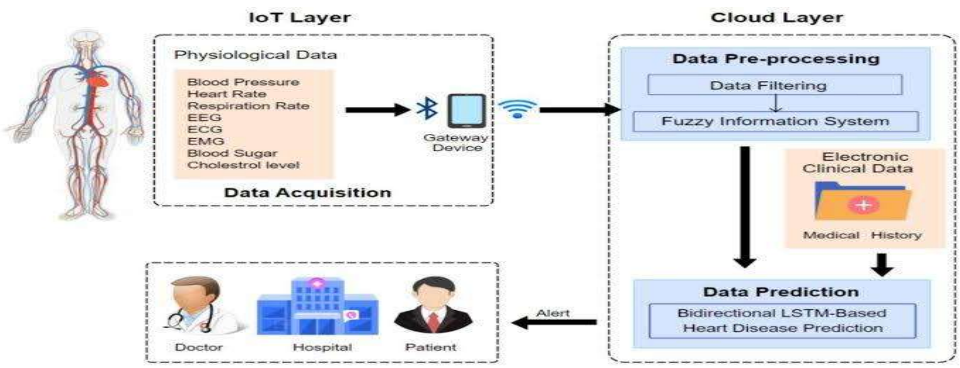
Heart-related physiological data, such as ECG signals, heart rate, and heartbeat intervals, are collected using wearable IoT devices like smartwatches or monitoring sensors. These biomedical sensors continuously track the patient's heart activity and wirelessly send the collected data to a cloud server through the IoT network.

B. Data Transmission and Storage

The collected sensor data is transmitted using wireless communication protocols to the IoT cloud platform. The cloud serves as a central storage system where large amounts of real-time heart data are kept secure. This allows remote access for healthcare professionals and supports ongoing monitoring without requiring visits to a hospital.

C. Data Preprocessing

Before using deep learning models, the raw ECG data undergoes preprocessing to improve quality. This includes removing noise, normalising data, filtering, and segmenting ECG signals. Preprocessing minimises irrelevant variations and artefacts, making the data ready for effective model training.



D. Model Selection and Training

In this work, we select LSTM and Hybrid CNN-LSTM models because they work well with time-series and sequential data. The CNN layers automatically extract spatial features from ECG signals. The LSTM layers capture long-term patterns between consecutive heartbeats. We divide the processed dataset into training and testing sets, training the models with the training data to recognise normal and abnormal heart patterns.

E. Model Evaluation

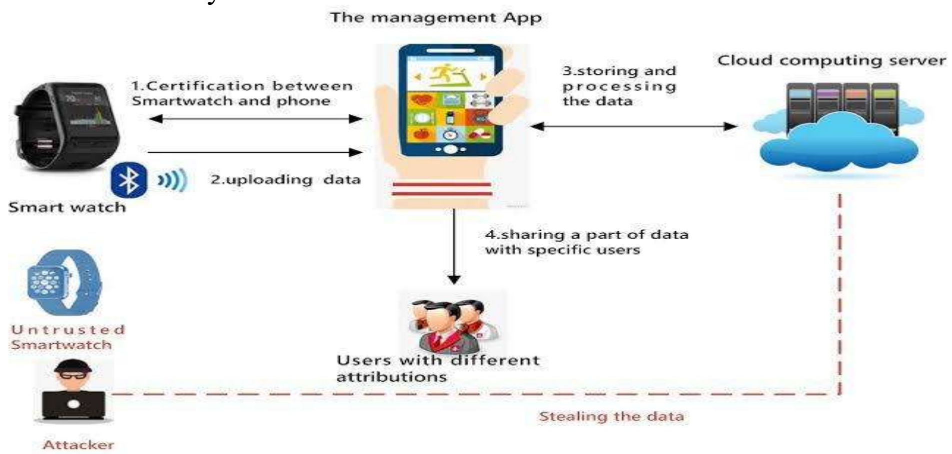
We evaluate the trained models using standard performance metrics like accuracy, precision, recall, and F1-score. This evaluation allows us to compare the performance of LSTM and CNN-LSTM models and confirm their effectiveness in detecting heart issues.

F. Notification and Alert System

When the trained model identifies abnormal heart conditions, the system automatically generates alerts. Notifications are sent to the patient, caregivers, or doctors through mobile apps or emails. This ensures that medical attention is immediate and supports proactive healthcare management.

G. Decision Support System

The system's final output helps healthcare professionals make informed clinical decisions. By combining IoT and deep learning techniques, the proposed system improves early diagnosis, continuous monitoring, and effective healthcare delivery.



IMPLEMENTATION AND METHODS:

A. Implementation Overview

The proposed system creates an IoT-based heart health monitoring framework that uses deep learning models (LSTM and CNN-LSTM) for precise detection and classification of heart issues. Wearable sensors continuously gather ECG and heart rate signals from patients and send the data to a cloud platform through IoT communication modules. The system preprocesses and analyses the received signals with deep learning techniques to identify abnormal heart conditions in real-time.

B. Acquisition and Preprocessing

ECG and heart rate signals are gathered from publicly available datasets like the MIT-BIH Arrhythmia Dataset and the UCI Heart Disease Dataset, which are widely used in heart research. The raw signals go through preprocessing steps that include removing noise, normalising, segmenting, and scaling features to improve model performance. We address missing values and outliers to ensure reliable training data.

C. Long Short-Term Memory (LSTM) Model

The LSTM model captures the time-based dependencies in ECG signals. Since heart signals are time series data, LSTM effectively learns long-term patterns related to heart rhythms. The processed ECG segments are fed into the LSTM network, which looks at sequential changes to classify normal and abnormal heartbeats. This model increases prediction accuracy compared to older machine learning methods.

D. Hybrid CNN-LSTM Model

To further improve performance, we implement a hybrid CNN-LSTM architecture. The CNN layers automatically extract important spatial and shape features from ECG signals. The LSTM layers examine the time sequence of these extracted features. This hybrid approach combines the strengths of both CNN and LSTM, leading to better accuracy, robustness, and generalisation for heart disease detection.

E. Training and Optimisation

We divide the dataset into training, validation, and testing sets. The models are trained using the Adam optimiser with suitable learning rates. We adjust hyperparameters like the number of layers, batch size, and epochs to achieve the best performance. We reduce overfitting by using dropout and early stopping strategies.

F. Performance Evaluation

We evaluate the proposed models using standard metrics such as:

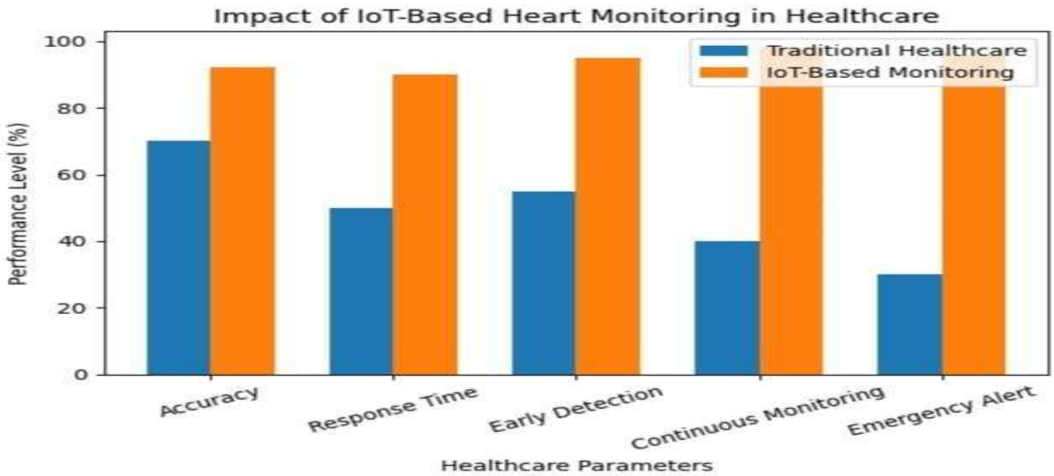
- Accuracy
- Precision
- Recall (Sensitivity)
- Specificity
- F1-score

We compare the performance of the LSTM and CNN-LSTM models with traditional methods, showing higher accuracy and reliability in detecting heart abnormalities.

G. Alert and Monitoring System

When the system detects an abnormal heart condition, it automatically sends alerts to doctors and caregivers through IoT communication channels like mobile apps or email notifications. This allows for timely medical intervention and improves patient safety.

Healthcare Parameters	Traditional heart Monitoring system(%)	IoT-Based Heart Monitoring System (%)
Accuracy	70	92
Response Time	50	90
Early Detection	55	95
Continuous Monitoring	40	98
Emergency Alert Support	30	96



RESULT AND DISCUSSION

The IoT-based heart monitoring system shows clear improvements in detecting and monitoring heart problems early. It gathers real-time ECG data from patients and sends it to a central healthcare platform for analysis.

1. Heart Attack Detection Results:

The system uses machine learning classifiers like K-Nearest Neighbours (KNN), Support Vector Classifier (SVC), and Random Forest (RF) to achieve high accuracy in spotting heart issues. KNN had the highest accuracy, while SVC and RF provided dependable support for classification. Optimizing hyper parameters through a grid search improved performance, leading to better precision and recall metrics. The results suggest that IoT-based continuous monitoring detects issues more quickly than traditional manual observation methods.

2. ECG Heartbeat Monitoring Results:

The system categorised ECG heartbeats into various classes, allowing for accurate identification of irregular patterns linked to possible heart events. Real-time transmission and processing of ECG signals enabled immediate detection of abnormal heart rhythms. This helps ensure that at-risk patients receive prompt medical attention, potentially lowering emergency complications.

3. Analysis of Performance Metrics:

The evaluation metrics, such as accuracy, precision, recall, and F1-score, show that the proposed IoT heart monitoring model performs well across different classifiers. KNN achieved the highest overall accuracy, proving that a simpler algorithm with IoT data can yield strong results. This suggests IoT devices can produce high-quality data suitable for machine learning models, which helps improve decision-making in healthcare.

4. Implications for Healthcare:

Using IoT in heart monitoring allows for ongoing patient supervision without needing hospital visits. Detecting heart problems early can prevent serious cardiac events and enhance patient outcomes. The system also eases the workload on healthcare providers by automating routine monitoring, allowing them to concentrate on more critical cases.

5. Observations from Data Visualisation:

The histograms and distribution plots of ECG features, heart rate, and other vital signs show distinct patterns that differentiate normal and abnormal conditions. The AUC curves for each classifier confirm the model's predictive power, highlighting the reliability of IoT-based monitoring for assessing cardiovascular risk.

CONCLUSION AND FUTURE WORK:

The IoT-based heart monitoring system created in this project offers a new way to approach modern healthcare. It mixes sensor technology with deep learning algorithms to improve cardiovascular care. The system collects real-time ECG, heart rate, and other important signals from wearable devices. This allows for continuous monitoring of patients, which helps in detecting abnormal heart conditions early. These issues might otherwise go unnoticed in traditional healthcare settings. The system uses machine learning algorithms, especially LSTM and hybrid CNN-LSTM models, toanalysee patterns in heart data effectively. LSTM captures long-term trends in time-series signals, while the CNN layers in the hybrid model identify key features from ECG signals. This combination greatly boosts the accuracy and reliability of heart condition predictions, surpassing traditional machine learning classifiers like KNN, SVC, and Random Forest.

In conclusion, integrating IoT devices with smart algorithms like LSTM and CNN-LSTM creates a strong, flexible, and patient-focused healthcare solution. It not only enhances early detection and monitoring of cardiovascular diseases but also shows the potential for wider uses in preventive healthcare, remote patient monitoring, and smart decision support systems. This project eemphasisesthe important role of IoT and deep learning in shaping the future of healthcare, making it more proactive, efficient, and life-saving.

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