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# Heart Disease Identification with the Support of Embedded IoT in Hospitals

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***Abstract*—In this paper, we will look at how to detect heart disease in hospitals using embedded IoT. The proposed method is based on the integrated internet of things in hospitals. It communicates wirelessly and can cover the user's immediate surroundings. By transmitting a series of voice control stored in the system's memory card, information about the environment is expressed to the user via headphones. To prevent interference among two or more devices nearby, appropriate connectivity techniques were also integrated into the prototype. Finally, the effectiveness of the device is evaluated and illustrated using experimentations and statistical analysis**.

***Keyword—AI, Internet of Things (IoT), wearable IoT, Hospitals, Heart Disease***

## I. Introduction

Nowadays, regular health monitoring is critical. Wireless health monitoring of a patient is a modern concept. It is a significant advancement in the medical field. Using current technologies such as potable communication, wireless systems, and wearable health monitoring devices which are controlled in the remote process, healthcare providers have established a better health monitoring system that supplies a comfortable lifestyle to patients who are infected with different diseases [1]. As information about the patient's health reaches the doctor's screen from wherever the patient does have any symptoms with him, doctor visits to patients are constantly decreasing. Based on this, physicians may also save a lot of lives by providing timely and beneficial care.

The majority of individuals are experiencing health difficulties as a result of the increasing societal pressure, and the majority of these problems are caused by repeated heart attacks. It is of the utmost need to develop a reliable method that is able to predict the occurrence of heart attacks or atrial fibrillations before they take place. Because the Internet of Things (IoT) is the most rapidly developing and widely used technology in the current age, combining traditional computing with IoT has resulted in the development of highly effective new technologies [2]. The combined system offers a variety of benefits to the user, such as the ability to detect the possibility of heart disease based on the patient's symptoms during an emergency, communicate with medical professionals regarding the severity of the potential disease, and assist in the treatment of the condition [3-4]. In the event of a medical emergency, the system will immediately notify the situation to the chosen physician. The severity of HD may now be diagnosed in patients by the use of electrocardiograms (ECG), exercise stress tests, chest X-rays, CT scans, MRI, coronary angiograms, and other diagnostic procedures. Patients need prompt and accurate diagnosis of coronary heart disease in order to be eligible for timely and appropriate therapy that will improve their chances of surviving the long term. In many parts of the globe with low resources, cardiologists who are qualified to perform these diagnostic tests may not be accessible. In many instances, the health of patients is placed in jeopardy due to the failure to detect a condition, the wrong diagnosis of a condition, or inappropriate treatment [5-6]. In addition, the early discovery of HD leads to preventive measures such as medicines, changes in lifestyle, angioplasty, or surgery, all of which may assist to slow the progression of the illness and reduce morbidity [7]. As a consequence of this, accurate and prompt diagnoses of heart disease are essential for reducing death rates and improving patients' chances of surviving for a longer period of time. It is difficult to diagnose coronary heart disease in its early stages, which is one reason why computer-assisted methods for detecting and diagnosing heart disease in individuals have been created [8]. Approaches that use machine learning to assess clinical data, evaluate it, and diagnose medical disorders are becoming more widespread in healthcare domains. These methods are used in medical facilities.

## II. Literature Review

Wang, Wanqing, et al. (2021) and Latchoumi TP et al (2022) sought to improve clustering technology to improve the design of IoT medical embedded devices. The system

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aims to align a file's onset and loads illness symptoms input from the user data into the input given. Find a match if the signs are preloaded, which will result in a prevalent prescription medication response and illness names in the system. Angina does not indicate that a cardiac attack occurs [9]. Katake, Kanchan. (2020) and Karnan B et al (2022) investigated existing wearable devices for measuring heart-related parameters and creating sensors for stress hormones, heart aging, and cholesterol. They aimed to create an algorithm that would create an alarm in the event of a threat to human life and would forecast any heart disease using existing evidence as well as data generated by IoT devices [10-11]. They intended to create ML and DL algorithms for this prediction by analyzing existing approaches. Khan, Mohammad Ayoub. (2020) and Sivakumar P (2015) suggested an IoT-based system to more accurately analyze heart disease using a Modified Deep CNN. The patient's BP and ECG are monitored by the smart device and heart tracking device. The MDCNN is used to categorize received sensor data as normal or abnormal. The system's performance is evaluated by comparing the proposed MDCNN to existing logistic regression and also the NN models [12]. The results show that the proposed MDCNN-based heart disease prediction system outperforms other methods. Rahaman, Ashikur, et al. (2019) designed and implemented an inbuilt sensor system with a low-power communication interface to collect ECG and body accelerations in a public setting using a smartphone. A wearable sensor is used to monitor ECG patterns, as well as the smartphone's built-in sensors, such as accelerometers and GPS sensors, to measure the user's body acceleration and location [13-15].

Al-Makhadmeh, et al. (2019) and Monica.M et. al. (2022) described IoT-based medical equipment for collecting heart data from patients before and after heart disease. To handle the data, a higher order Boltzmann deep belief neural network is used that is continuously transmitted to the health care center. The DL method learns heart disease features from previous analysis and achieves efficiency through effective data manipulation. Raj, Sandeep, et al. (2020) and Sridaran K et. al. (2018) proposed a novel that is always enough efficient methodology while comparing it with the real-time acknowledgment ECG signal [16-17]. The approach extracts characteristics from heartbeats using a fast Fourier transform-based discrete wavelet transform, which has a lower computing cost in terms of addition and multiplication operations. These extracted features are identified using a PSO-tuned twin SVM classifier [18-19]. The PSO model is used to gradually adjust the classifier parameters to attain accuracy, and the TSVM classifier is quicker than the fundamental SVM models. To categorize 16 classifications of ECG signals, the method is implemented on an IoT-based console that is most related to the microcontroller and validated with the default benchmark Physionet information [20]. Umer, Muhammad, et al. (2022) and Vemuri et al (2021) to enhance heart failure patient survival prediction without depending on human feature engineering, an intelligent healthcare framework based on IoT and cloud technologies has been developed by Buvana M et al (2021). The intelligent IoT-based system recognizes patients in real-time and offers patients with heart failure timely, effective, and high-quality healthcare services [21-22]. The suggested model also investigates deep learning models for identifying individuals with heart failure who are still alive or have passed away.

## III. Proposed Work

A built-in sensor system with a low-power standard interface for collecting ECG and body accelerations in public using a smartphone A wearable sensor, as well as the device's built-in sensors, such as accelerometer sensor and GPS sensors, are used to measure the user's body acceleration and location. The proposed digital health care framework is based on IoT and cloud technologies and is designed to improve heart disease patient survival forecasting without relying on feature engineering. The smart Internet of Things-based framework detects patients in real-time and provides patients with severe with prompt, effective, and high-quality healthcare services. The proposed model also investigates DL models for deciding whether patients with heart failure are alive or dead. The framework collects data from IoT-based sensors and sends it to a cloud web server for processing.

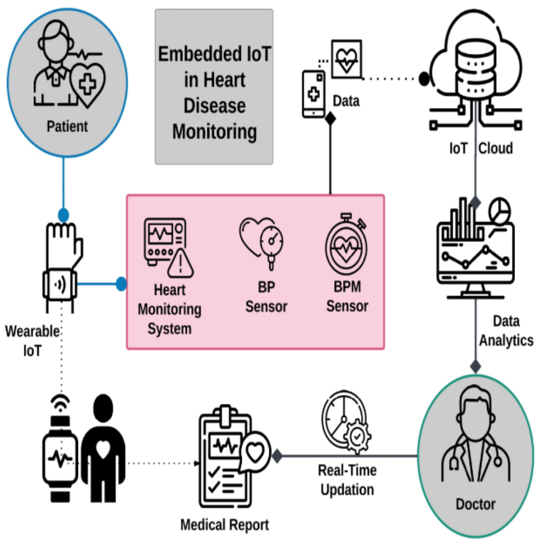


Fig.1. Proposed architecture

Where f(p,q) denotes the pixels in the neighborhood of noise pixel and $\hat{g}(e,x)$ shows the median pixel value. To determine if an individual pixel in a picture has noise, the median filter compares it to all of the surrounding pixels. It is possible to change the size of the neighborhood and the criteria for comparison is calculated using Equation (1).

$$g(e,x) = \underset{(p,q) \in R_{ex}}{mean} \{f(p.q)\} \tag{1}$$

$$F(e,x) = \begin{cases} 1, (e,x) \epsilon P_f \\ 0, otherwise \end{cases} \tag{2}$$

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$$N_{s,\theta=0(r,s)} = \sum_{m=1}^{M}\sum_{n=1}^{k}\begin{cases}1 & c \\ 0 & otherwise\end{cases} \tag{3}$$

$$\sum_{p,q}|v-u|^2 q(p,q) \tag{4}$$

In Equation (3), c takes its value according to the condition of if I(p,q) = p *and* I(n, m+s) = q, and p, q = 0, 1, …., l-1.

$$\sum_{p,q}\frac{(p-\mu p)(q-\mu q)q(p,q)}{\sigma_p \sigma_q} \tag{5}$$

The letter "l" stands for the number of grey tones. The letters M and C indicate the image's dimensions.

$$\Sigma(p,q)\frac{u(p,q)}{1+|q+p|} \quad (6) \tag{6}$$

And the (v,x) grey tone is denoted by q(v,x).

$$H_{pc} = -\sum_{m=1}^{M_{pc}}\sum_{n=1}^{N_{pc}} q_{pc}(m,n)\ .\log q_{pc}(p,q) \tag{7}$$

## IV. Experimental Results

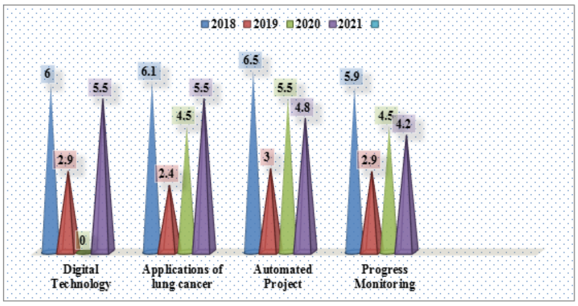

Fig.2.Analysis of comparison of previous models

By changing the different k-folds, the effectiveness of the smart healthcare prediction model is evaluated and contrasted with algorithms and classifiers as shown in Fig.2. The GSO-CCNN-based smart healthcare prediction model's better performance is assessed utilizing a variety of performance criteria. The MCC of planned GSO-CCNN is nine percent, 10.4 percent, 11.7 percent, and 7.9 percent more advanced when the k-fold is assumed to be 2. The general effectiveness of proposed smart healthcare modeling with IoT-based fog and cloud computing for various metaheuristic-based algorithms and classifiers.

TABLE I. Performance Measures

| Algorithm | Patients Activity in Training (%) | Patients Monitoring in testing (%) | Overall Accuracy (%) |
|---|---|---|---|
| (ML) Algorithm | 89.78 | 98.67 | 84.01 |
| Neural Network Model | 91.78 | 92.56 | 94.67 |

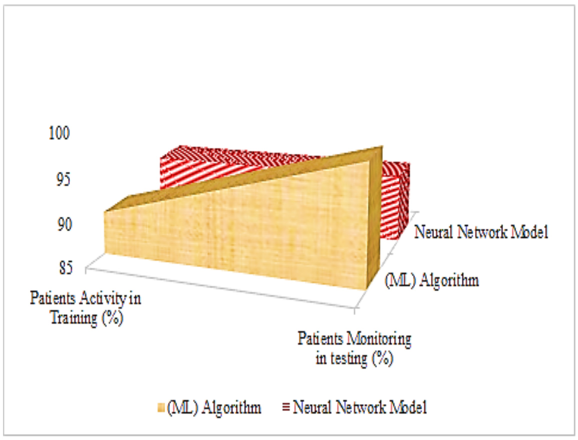

Fig.8. Training and Testing Analysis

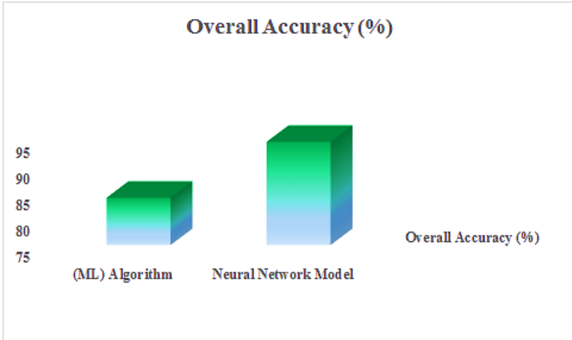

Fig.9. Accuracy Analysis

The comparative research of the suggested smart healthcare model with IoT-assisted fog computing is expressed in terms of k-fold validation by setting the k-fold to 5, as indicated for different metaheuristic-based algorithms and classifiers, respectively. Machine learning models are evaluated on a short data sample using a resampling approach called cross-validation. Fig.3 and Fig.4 represents the comparative analysis of the proposed Machine Learning model on Neural Network Models and the results show that the Machine Learning model has outperformed the existing model. Table I represents the numerical analysis of these figures.

## V. Conclusion

The framework makes use of IoT-based which helps in the collection of data and shares it to a cloud server to make use of it in further processing. Chui, Kwok Tai, et al. (2019) proposed a response to a patient monitoring system that is based on IoT. Qualitative research is being conducted on selected analytics which evaluates the behavior, cardiovascular disease identification, and fall detection. Gia, Tuan Nguyen, et al. (2019) proposed low-energy monitoring for diabetic patients with cardiovascular disease using a fog-aided IoT system. Kazi et al. (2018) developed a real-time cardiovascular disease monitoring system that is most related to continuous focusing on the patients instead of doctors or as like the doctors physically monitoring the patient. IoT-based sensor management becomes a huge environment for several applications and services, with Raspberry Pi acting as both a controller and a sensor node.

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The study suggests a universal patient monitoring system as the next step in the department's development thus far.

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