Machine Learning–Based Pre-Stroke Detection System

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Abstract- Stroke remains a significant health concern worldwide, often leading to severe disabilities and mortality. Early detection and intervention are crucial for preventing strokes and mitigating their impacts. In this study, the proposed machine learning-based pre-stroke detection system aimed at identifying individuals at risk of experiencing a stroke before the onset of symptoms. The proposed system utilizes a diverse dataset containing demographic information, medical history, lifestyle factors, and biomarkers relevant to stroke risk. Various machine learning algorithms, including Decision Tree Algorithm, Random Forest Algorithm, Naïve Bayes Algorithm, Multilayer Perceptron Algorithm, and J Rip Algorithm, were trained, and their evaluation was conducted separately using the dataset. The proposed system uses a cloud-based stroke warning system that utilizes machine learning technology to predict impending strokes. The peculiar scrutiny of many machine learning methods led to the development of an effective machine learning strategy for the precise detection of strokes. A microcontroller-based system was used to establish and exhibit an actual patient monitoring system that can sense a variety of real-time indicators, including core temperature, blood pressure, blood flow, heart rhythm, and oxygen level, to let caregivers and doctors keep an eye on stroke patients around the clock. Decisions can be made quickly and easily with the aid of various decision-making algorithms, and anyone can access the database according to their needs.

Keywords: Stroke detection system, cloud based system, Smart health, health monitoring system, virtual monitoring system

I. INTRODUCTION

Globally, ischemic stroke stands as the leading cause of mortality. By analyzing acute-phase stroke symptoms with diffused magnetic resonance imaging (MRI) data, the severity of alterations in the vascular territory of the obstructed blood vessel in stroke can be precisely determined. [1] Due to their sensitivity in detecting small infarcts in the brain stem and deep structures within the cerebral hemispheres, MRI scanners are especially useful for facilitating the detection of early stroke infarcts. The most frequently employed modality of magnetic resonance imaging (MRI) is diffusion-weighted imaging (DWI), which detects even minute alterations in water diffusion to identify acutely ischemic brains. Manual delineation of aberrant brain tissue is the conventional approach for lesion identification; nevertheless, it is a labor-intensive and operator-reliant procedure. When it comes to the procedures of disease diagnosis and treatment [2], the precise definition and timing of the injury identification process are critical. In order to eliminate inter-subject variation, researchers have proposed entirely automated methods for identifying damaged brain tissue and analyzing large MRI datasets. In order to identify stroke lesions, scientists have devised manual, semi-automatic, and automated methods over the last two decades, utilizing edge detection, thresholding, clustering, wavelet, watershed transformation (WT) [3], and graph cut theory. The potential medical implications of this discovery are extensive in scope. Using the proposed procedure, brain strokes can be identified with extreme precision. The potential medical implications of this discovery are extensive in scope. It is caused by blood entering the site of a brain injury. [4] In the absence of oxygen, brain cells expire when this occurs. The degeneration of neurons in the region of the brain responsible for memory and motor control results in the impairment of these two cognitive abilities. Facial, limb, or lower extremity weakness or numbness on one side of the body are common indications of a cerebrovascular accident. Vision impairment in one or both eyes and speech impairment have both transpired. Additionally, the patient may experience abrupt onset of severe vertigo, loss of equilibrium, and a severe headache. Moreover, there may be the possibility of confusion and loss of consciousness, as well as growing tiredness.

An estimated 41 million people died in 2016 as a result of non-communicable diseases. Cardiovascular disease

accounted for a significant proportion of the total, accounting for 17.9 million fatalities or 44% of all deaths attributable to non-communicable diseases. [5] PMS, which resembles a palm top, monitors health metrics continuously and notifies service providers of any ambulatory conditions. Like a point-to-point system, it operates. Maintaining one such system for each patient at a hospital with several patients will be more expensive. Although the suggested system uses the internet to inform the authorities of the state of patients, it may measure a variety of physical parameters of different patients. It primarily focuses on the software components of creating a system that can access a database that contains various patient health parameters.

II. Existing System

The fundamental objective of the healthcare industry is to provide exceptional medical care to all individuals, irrespective of their location or time, across the globe. This should be accomplished in a more patient-friendly and cost-effective manner. Hence, patient monitoring equipment needs to be improved to increase the efficiency of patient care. Body sensor network (BSN) technology is a critical component utilized in modern healthcare systems that are supported by the Internet of Things (IoT). It is an array of wireless sensor nodes with minimal power consumption and portability that track bodily processes and the environment. [6] BSN nodes need rigorous protection measures to safeguard unauthorized utility to the system because they are used to gather sensitive (life-critical) data and may function in hostile area. The existing system is not without its drawbacks.

- The doctor failed to send the patient's prescription.
- Wired network limitations on body movement
- Interference from multiple devices using the same channel

III. Proposed System

A wearable gadget will continuously track a person's health. Stroke rate data based on temperature, pressure, and other variables is sent to the cloud and used for machine learning. The main intention behind machine learning is to classify whether the electronic sensor data is normal or abnormal. Through the use of machine learning (ML), the data set, including medical features, is compared with actual hardware data to provide a precise state that minimizes the difficulty of time and might even save numerous souls. In this method, a strategy is proposed to predict stroke by employing a variety of variables that are autonomous and regularly collecting a pulse rhythm since it fluctuates. [7] The Internet of Things (IoT) and cloud-based services are employed to communicate with the individual, and multiple regression is used to forecast stroke attacks and remind patients of their health after a stroke. The system's security and capability to transmit sensor data and execute machine learning over the internet are its key merits. To compare the patient's current condition with their medical history, doctors might consult the server database itself. It enables multivendor off-the-shelf hardware device plug-and-play to avoid proprietary standards in the process [8-17]. Figure 1 shows the block diagram of the proposed system.

The proposed system uses a microcontroller for decision-making; it also consists of various sensors like a pulse, Spo2, and flex sensor for analyzing the health condition of a patient. By taking the real or existing value of data received from sensors, the microcontroller has already attached some predefined value of data. The microcontroller will compare the actual dta with the predefined value; if there is any deviation, the related information will be sent to the nearby clinic. All the data will be frequently gathered and saved on the cloud platform. If there is any medical necessity, the doctor can refer to the previous data record to prove any suggestions to the patient for their health improvement.

Block Diagram

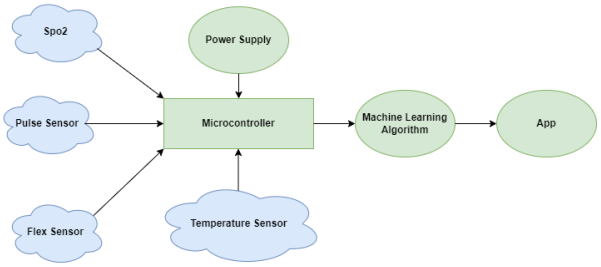

Figure.1. Block diagram

IV. Hardware Setup

Hardware prototype modelling of the proposed method is constructed by using various sensors for monitoring oxygen level, temperate, heart rate of an individual.

In the proposed system, data is collected by the various sensors like Spo2, pulse, flex, and temperature; the collected information is fetched to the microcontroller. Pulse and Spo2 sensors are used to detect the pulse and oxygen level of an individual; this is one of the factors used to recognize stroke. A flex or bend sensor is used to identify physical repercussions. Among the stroke's most common side effects are physical repercussions. One side of the body typically experiences normal muscle weakness, paralysis, stiffness, or changes in sensation. Basically, it is a resistive sensor. This sensor detects bends or physical deformations based on the variation and gives information to the microcontroller. In addition to that, the proposed system also uses a temperature sensor for detecting the temperature. Based on the information received from sensors, the microcontroller gives data to a machine learning algorithm, which is a decision-making block where decisions can be made based on the received

data. In this proposed method, the testing was done with five different types of machine learning algorithms, like those for decision-making. Random forest algorithms are used because supervised learning algorithms like random forests can address both regression and classification problems. They address these issues by training a large number of decision trees in a distributed manner. When engaging with classification issues, the outcome of random estimation is the class that the vast number of trees adopt. The proposed method is developed by using supervised method, a practice that employs multiple classifiers to address complex problems and boost a model's effectiveness. As suggested by its name, the random forest classification algorithm incorporates forecasts from multiple decision trees, rather than just one, and aggregates them to improve the predicted precision. In this case, the results are determined using the most frequently cited forecasts. As compared to other algorithms, the random forest approach has a high accuracy rate. Figure.2 shows the hardware prototype of the proposed method.

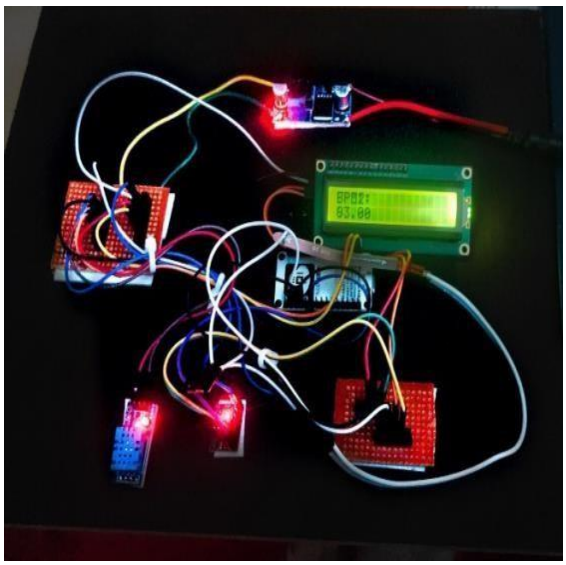

Figure.2 Hardware Prototype

Based on the proposed prototype model, data was collected from an individual and saved on the cloud platform. On the basis of the stored data, the decision will be taken by the machine learning-based algorithm. This process is performed for different algorithms, and its appropriate accuracy is monitored, which is tabulated in Table 1.

Table 1 Accuracy for different algorithms

Classification of Algorithm	**Accuracy**
Decision Tree Algorithm	96.15%
Random Forest Algorithm	98.94%
Naïve Bayes	75.74%
Algorithm	
Multilayer Perceptron Algorithm	80.80%
J Rip Algorithm	94.94%

Based on the measured data the patient monitoring system for stroke identification gets operate under two different modes.

- Mode-1: When the individual is healthy
- Mode-2: When the individual is not healthy

Mode-1: When the individual is healthy

In this mode, when the individual is healthy, the health monitoring system for stroke identification generates data, as shown in Table 2, and in the mean time, data can be viewed via a mobile application, as shown in Figure 2.

Table.2. Monitoring Parameter of an individual under normal condition

Values	Temperature	BPM	SpO2	Lump	Result
Standard	34	92	98	99	Healthy
Standard	34	92	98	98	Healthy
Practical	34	92	98	97	Healthy

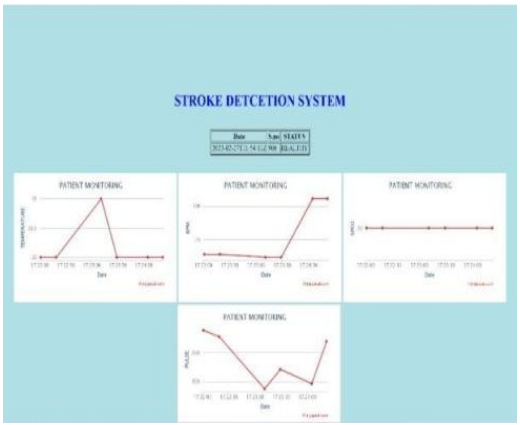

Figure 2 Health monitoring system under normal operating condition

Mode-2: When the individual is not healthy

In Mode II, when the individual is not in a normal condition, information should be given to the concerned person as well as the doctor for procuring the treatment. In this case, sample data was taken in the proto type, as shown in Table 2, and its corresponding information is displayed in the mobile application, as shown in Figure 3.

Table.3. Sample data of an individual under Mode-II

Values	Temperature	BPM	SpO2	Lump	Result
Standard	33	88	91	175	Go to Hospital
Standard	34	89	90	176	Go to Hospital
Practical	32	93	89	177	Go to Hospital

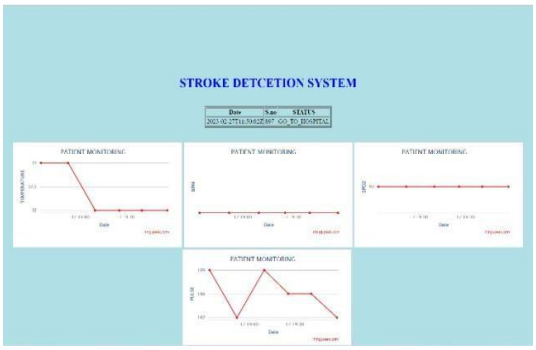

Figure 3 Response of the health monitoring system under Mode-II

V. Performance Comparison

Table.4. Performance comparison table

EXISTING SYSTEM	PROPOSED SYSTEM
Uses sensor to detect the health condition	Implemented with advanced ML based algorithms for more accurate decision making.
It is provided with sensors but datas are not outsourced for further action	Since the device is integrate with cloud and mobile application, datas are used for further process
Emergency situation cannot be tackled by the device on its own	Emergency situation can be managed by providing health information to the concern person and hospital immediately if any illness is found

Table 4 illustrates the performance comparison of the existing and proposed system. It clearly shows that proposed system is better than existing system where as the proposed system is enhanced with special features like better decision making, datas can be outsourced for further process and emergency situation handling.

VI. Conclusion

A health monitoring system for monitoring strokes has been developed with a prototype and mobile application. With the help of this proposed system, the entire data of an individual can be collected and used for further treatment. In this proposed method, a machine learning-based algorithm is used to detect the stroke with a maximum accuracy of 98.94% using a random forest-based machine learning algorithm. This developed prototype system can also be accessed through a mobile application, which also displays the prescription and the current state of an individual. Patient monitoring systems for stroke identification based on machine learning are especially beneficial for the prevailing scenario since they enable patients to continue living their lives while still receiving continual medical care. It is imperative that those patients who are actually deserving of it be compelled to visit a clinic or a physician. However, users of the system are often less acclimated to it and have less confidence in their ability to utilize it, despite the fact that many patient monitoring systems are used to provide medical treatment within hospitals. Because of this, it is extremely important to urge patients to engage in an active and voluntary manner. Those suffering from chronic diseases should not only communicate with medical experts but also establish connections with each other.

VII. Future Scope

- Continuously refining and improving predictive models using advanced machine learning algorithms such as deep learning, reinforcement learning, or ensemble methods to increase the accuracy and reliability of stroke risk prediction.
- Integrating data from various sources such as medical imaging (MRI, CT scans), genetic data, electronic health records (EHRs), wearable devices, and lifestyle factors (diet, exercise) to create a comprehensive predictive model. This would provide a more holistic understanding of an individual's stroke risk.
- Customizing stroke risk assessment models based on individual characteristics such as age, gender, medical history, genetic predisposition, and lifestyle factors. This personalized approach can lead to more accurate risk predictions and tailored preventive strategies.
- Developing techniques to make the predictions of the pre-stroke detection system more interpretable and understandable to healthcare providers and patients. This would increase trust in the system and facilitate better decision-making regarding preventive measures.
- Addressing ethical considerations such as data privacy, consent, bias, and fairness in the development and deployment of pre-stroke detection systems. Ensuring compliance with regulatory standards and guidelines to safeguard patient rights and ensure the safety and efficacy of the technology

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