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Patient Monitoring System Using Deep Learning Algorithms To Recommend Physical Exercise

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***Abstract*— The Internet of Things (IoT), which allows common household items to be connected to the internet and communicate with one another, is quickly changing the way we live and work. The healthcare, transportation, and manufacturing sectors could all undergo radical change as a result of this. if a little developing method have led to a number of new developments in the medical and health fields. IoT technologies for wearable health address new problems with state-of-the-art equipment and resources. With the aid of portable medical equipment, the health status of both in- and out-patient patients could be monitored frequently and irregularly. This paper suggests the Patient Health Monitor Framework (PHMF), an IoT application framework that uses Machine Learning (ML) techniques to create a better automation system. Connections, surveillance, and decision-making for precise diagnosis will be made possible by this system.**

***Keywords*—IoT, Healthcare, physical monitoring, Machine Learning techniques**

I. INTRODUCTION

The application of a sustainable and environmentally friendly strategy is a crucial component of our project. During the entire project lifecycle, we are dedicated to minimizing waste and reducing our carbon footprint. Health is life. Due to their busy schedules and workloads, people don't pay attention to their health and fitness. Physical inactivity is the biggest problem today's youth are facing [1-2]. People can maintain their physical fitness by continuing their regular physical activities and adopting healthy lifestyle habits, such as eating a balanced diet, getting enough sleep, and lowering their stress levels by practicing relaxation techniques like yoga or meditation. For a fulfilling life, it's critical to priorities our health and carve out time for self-care. When taken as a whole, nutrition and exercise change depending on the users' lifestyles, height, weight, sex, age, & degree of activities [3-4]. Exercise and healthy eating go hand in hand. It's important to manage your calorie consumption if you want to keep your blood sugar levels stable. Therefore, the proposed approach would enable physicians to click a mouse and counsel exercise and diet to their customers who have diabetes, hypertension, or thyroid problems in addition to the medicine they prescribe at every follow-up [5-8].

However, one use is the remote monitoring of clients' healthcare, which enables medical professionals to keep a closer eye on their patients and prevents the progression of medical issues even in regions with limited to distant healthcare facilities [9]. Remote monitoring enables faster diagnosis & prompt, appropriate treatment by giving medical professionals access to timely or past health information in real-time [10]. Even though it reaches regions with limited access to health facilities telemedicine has the potential to improve healthcare delivery and reduce healthcare disparities by providing remote consultations, diagnoses, and treatment options. However, it also requires reliable internet connectivity and trained healthcare professionals to ensure effective implementation. telemedicine has the potential to improve healthcare outcomes by providing remote medical consultations and diagnoses, as well as facilitating the delivery of medications and medical supplies. However, it also requires reliable internet connectivity and adequate training for healthcare providers to effectively utilize the technology. [11–12]. That underscores why such technologies have so far had little impact on rural India's patient and health industries. This essay introduces the idea of AmritaJeevanam, a specific healthcare infrastructure that attempts to serve rural communities' requirements [13].

II. RELATED WORKS

By utilising remote sensing capabilities, health monitoring technologies that are combined with IoT/BAN effectively revolutionise the healthcare sector [14]. Detection systems are used in conjunction with such systems to identify crucial parameters and transmit data to an acquiring device via Bluetooth, BLE, and WiFi. Medical and measurement data that has been collected through an intermediary device, like a gateway, is frequently sent to a distant server. For those who live in remote or rural areas, this technology makes it possible for medical professionals to monitor patients' health in real-time, even from a distance. Additionally, by enabling early detection and intervention of potential health issues, the use of IoT/BAN technologies in healthcare can enhance patient outcomes.Using this technology, healthcare professionals can [15]. Data transmission is kept on a distant server, assuring accessibility and accessibility at all times. Cloud-based systems are used to construct popular systems and store the gathered health information [16]. Numerous applications are offered by such healthcare monitoring platforms. However one tool, for instance, uses analytics to

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find individuals with serious cardiac issues from the medical information stored on computers.

Based on the acquired data, medical analytics helps uncover distinctive patterns or trends. Big data medical analytics in healthcare platforms offer practitioners insightful information that aids in choosing the best diagnoses [17]. Medical data analysis can help spot changes in medical trends or foretell the likelihood and likelihood of impending peril. It has been investigated in various systems to use a health platform and widely used mobile technology as an alarm system. These systems, which rely on Internet technology, allow for direct medical professionals to intervene [18]. The utilization of this type of healthcare system has, up until now, not been practical in the context of rural and isolated Indian populations which have low literacy levels, a lack of advanced technologies, limited access to medical facilities, and inconsistent or nonexistent broadband internet. These peoples are also digitally cut off from the rest of the world. This development's main goal is to tackle this issue by putting in place a cheap solution for rural healthcare monitoring and education.

III. Proposed Method

The use of IoT health wearables to gather patient data across various settings is a significant advantage in providing continuous monitoring and effective patient care. The ML classification methods used in constructing the training models enable accurate diagnosis and analysis, leading to better decision-making based on the collected patient data. Furthermore, the program's ability to share patient data with doctors, inpatients, outpatients, and caregivers enhances the quality of care that patients receive [19].

The program's focus on high-quality and secure services makes it an ideal platform for healthcare providers to offer healthcare services to their clients, providing them with accurate and prompt care. This feature could also be useful to researchers and healthcare policymakers, as the accurate and precise data gathered by the program could assist in identifying trends in the management of chronic conditions.

Overall, the PHMF program is a significant development in healthcare that can provide healthcare providers with an efficient way of managing chronic conditions and providing high-quality and secure care for their patients. The program's effectiveness could potentially reduce healthcare costs, improve patient outcomes, and enhance the overall quality of healthcare service delivery.

Wearable technology such as temperature sensors, heart rate monitors, eye lance-based diabetes sensors, and blood pressure monitors are suitable for transmitting real-time data from the human body to an e-health care monitoring system. These wearables can capture essential biometric data that doctors and healthcare providers can use to monitor a patient's health status continuously.

For instance, temperature sensors enable remote monitoring of fever or other temperature-related issues, heart rate monitors enable remote monitoring of heart rate patterns, and blood pressure monitors allow remote monitoring of blood pressure, which is critical for patients with hypertension. Eye lance-based diabetes sensors help monitor blood sugar levels and track insulin injections for diabetic patients remotely.Wearable technology is an important aspect of remote health monitoring, as it allows patients to receive care while reducing the number of visits to healthcare facilities. Healthcare professionals can also take advantage of the data gathered by these wearables to make informed decisions, improve diagnosis, and develop personalized treatment plans for their patients.The use of wearable technology in remote health monitoring is a promising development in healthcare. It enables a continuous flow of biometric data to healthcare providers and physicians, which in turn allows them to diagnose medical conditions early and take prompt action to provide the best possible patient outcomes. [20]. Using IoT architecture withML techniques aims to develop a new application model that provides a better solution and considerable improvement for many discrete health services. The PHMF software is linked to devices for data collecting and patient monitoring. Fig.1 depicts the proposed system design.

Each patient must sign up using a special wearable connected to the Global Positioning System. Wearable technology is practical because the patient may simply carry it with them at all times. These gadgets allow for the tracking of a patient's health status andthe location the patient [21-22]. At regular periods, the admin server will get the collected data. These limited gadgets and IoT applications are mostly managing new issues.

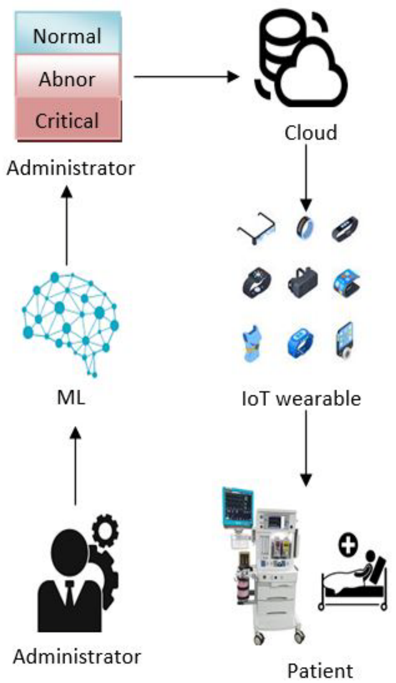

Fig. 1. Proposed Architecture

ML is a computational and statistical methodology that interacts with supervised and unsupervised learning approaches through data mining techniques. Fig. 2 depicts the key ML classification techniques such asK-Nearest

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Neighbor (K-NN), Decision tree, Support vector machine (SVM), and Regression algorithms.

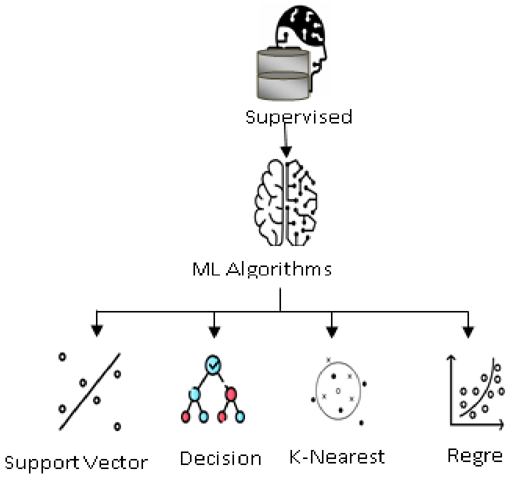

Fig. 2. Proposed ML classification

Currently, one algorithm has been selected by the authors for investigation. SVM recognizes a superior forecast here. The optimal optimization may be achieved by combining regression and classification algorithms. We will use an approach that defines a hyperplane to optimize the separation between the classes using mathematical techniques. plotting the data item in N-dimensional space on the view plane. The representation of data items has a variety of properties when the number "N" is taken into account. Each feature's value is determined by the value of a certain location. Researchers discover the hyperplane that differentiates two classes to be extremely well-equipped and prepared based on the categorization.

TABLE 1.DIABETICS DATASET DESCRIPTION

Items	Normal	Low	Abnormal	Critical
Pregnancies	4<=6	1<+4	7<=9	=>10 above
Glucose	80 mg/dL	120mg/dL<140	140mg/dL<=170	=>170 above
BP	<90mm Hg	70mm Hg<=80	90 mm Hg<=100	=>170mm Hg
Skin Thickness	25<=30	0<=25	40<50	50<=60

A. SVM in data visualization

i). The two classes are the subject of the best discrimination analysis in N-D space.

ii). Increase the space between the data points across all classes.

iii). Finding the margin length and variability of data elements on the hyperplane is its key restriction.

iv). The margin hyperplane may be used to precisely locate neighboring data items and missing values.

v). This could improve class precisely and eliminate certain classification faults.

The hyper lines cannot be used to separate the two classes. Outlier sets can be referred to in situations when the data items belong to a different class that does not control the anomalous sets and the diabetes dataset description is shown in Table 1.

IV. EXPERIMENTAL ANALYSIS

The use of the National Institute of Diabetes dataset on diabetic patients in the PHMF application is a step in the right direction in delivering accurate and personalized care. The use of large datasets such as these is crucial in training machine learning models to enable accurate classification of patients with diabetes. The dataset's inclusion of various age groups, particularly pregnant women, is also important, as gestational diabetes is a common occurrence during pregnancy that can lead to complications if not properly managed. Furthermore, the dataset's class label, which can have values of either 0 or 1 depending on whether the patient has diabetes or not, makes it easy to develop a classification model using supervised learning techniques.

By using the dataset for experimental investigation, the PHMF application can improve the accuracy of its predictive models, thereby enabling more personalized care for diabetic patients. The results obtained from the dataset can enhance the program's decision-making capabilities, leading to more accurate diagnoses, and improved patient management. This can lead to better outcomes for diabetic patients, especially those who may have difficulty accessing medical care due to geographic or socioeconomic factors.

The use of large datasets such as the National Institute of Diabetes dataset within the PHMF application is a significant development in delivering personalized and accurate care for diabetic patients. The dataset's class label and inclusion of pregnant women of different age groups are important features that make it suitable for experimental investigation and classification model development.

TABLE 2.SAMPLE DATA SET

	Pregnancies	Glucose	BP	Skin Thickness	Insulin	BMI	Diabetes	Age	Outcome
0	7	149	73	36	0	33.7	0.629	50	1
1	2	87	67	30	0	26.8	0.355	32	0
2	8	185	65	0	0	23.5	0.677	33	1
3	2	90	67	24	95	28.2	0.169	22	0
4	0	138	41	36	169	43.6	2.289	34	1

To determine if a person has diabetes or not, the SVM algorithm is used on datasets that have been trained on a computer. The likelihood of a specific consequence justifies the age at which a person develops diabetes and any further potential causes. For prediction analysis, the following two primary elements are taken into account: Age and the levels of glucose and insulin in the human body. The report's final result was patterned with two potential hues, such as Blue and Orange. Fig.3 shows the prediction analysis with age on the x-axis and glucose level on the y-axis. Fig.4 shows the prediction analysis with age on the x-axis and insulin level on the y-axis.

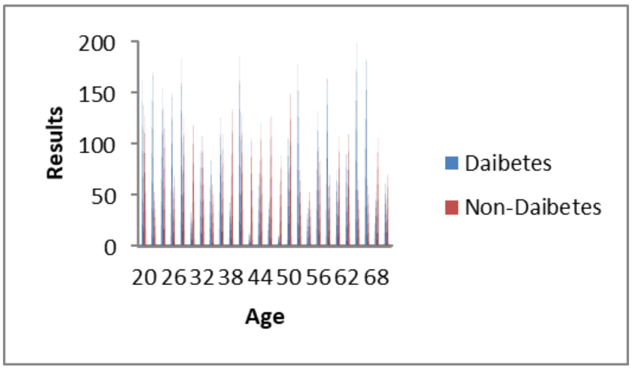

Fig. 3. Prediction analysis with age Vs glucose level

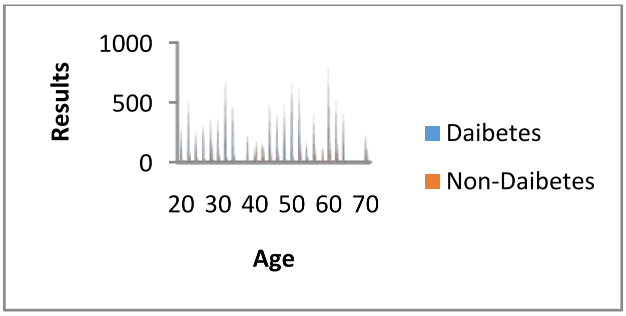

Fig. 4. Prediction analysis with age Vs insulin level

TABLE 3.PERFORMANCE ACCURACY

	Precision	Recall	F1-Score	Support
Diabetes	0.78	0.67	0.72	55
No-Diabetes	0.84	0.91	0.88	100
Micro Avg	0.82	0.80	0.82	155
Macro Avg	0.81	0.78	0.79	155
Weighted Avg	0.82	0.79	0.81	155

According to the performance metrics presented in table 3, the SVM algorithm outperformed other algorithms in the PHMF application in terms of efficiency, with a score of 80.51%. The other algorithms that were tested had the following efficiency scores: Gradient Boosting scored 77.27%, K Neighbour Classifier 71.42%, Decision Tree 70.22%, Random Forest 79.22%, and GNB 76.62%.

It is worth noting that although the SVM algorithm had the highest efficiency score, other algorithms such as Random Forest also performed relatively well, with a difference of only 1.29% compared to SVM.

Overall, the performance metrics presented in table 3 demonstrate the potential of machine learning algorithms such as SVM in delivering personalized and accurate healthcare services. By leveraging large datasets and applying supervised learning techniques, healthcare providers can improve diagnostic accuracy, enhance patient outcomes, and reduce healthcare costs. However, selecting an appropriate algorithm for a particular application requires careful consideration of several factors, including the type of data, the problem domain, and the specific requirements of the system..

V. CONCLUSION

The SMS service-related difficulties faced by PHMF in the provision of health-related services such as daily health alerts, medical appointments, and nutrition recommendations are understandable. However, hospitals can consider modifying PHMF software to provide the best-recommended E-Health services to patients using different communication channels such as emails, phone calls, or social media platforms.By adopting different communication channels, healthcare providers can enhance patient engagement, improve adherence to treatment plans, and achieve better patient outcomes. These channels can also enable remote communication, provide more convenient access to care, and offer personalized treatment options that suit patients' unique needs.

Furthermore, future improvements in the PHMF application can leverage emerging technologies such as artificial intelligence, machine learning, and data analytics to enhance diagnostic accuracy, predictive modeling capabilities, and personalized treatment options. These technologies can also support more effective patient monitoring, early detection of potential health issues, and prompt interventions to improve overall health outcomes. the adoption of different communication channels for the provision of healthcare-related services can potentially enhance patient engagement, improve adherence to treatment plans, and lead to better patient outcomes. Additionally, future improvements in the PHMF application can leverage emerging technologies to enhance diagnostic accuracy and personalized treatment options, leading to better patient outcomes and improved healthcare service delivery. We have gathered a set of diabetes data from web resources for an experimental demonstration of the proposed strategy. The dataset gathered is believed to be the same as the dataset gathered using wearable IoT-based technology. An ML method called SVM was applied to the dataset, and it produced an accurate result. To increase the effectiveness of the proposed approach, we want to collect data from IoT wearable devices and use more ML algorithms in further work.

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