IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Diagnosis Of Diabetes Using Artificial Intelligence Techniques By Using Bio Medical Signal Data

Akhand Shukla[1], Chandan Kumar[2]

[1]Computer Science & Engineering, I.E.T, Dr. Rammanohar Lohia Avadh University, Ayodhya, Faizabad, Uttar Pradesh, India.

[2]Assistant Professor, Dept. of Computer Science & Engineering, I.E.T, Dr. R M L Avadh University, Ayodhya, Faizabad, Uttar Pradesh, India

Abstract—

An estimated 463 million people around the world are affected by diabetes, a chronic metabolic condition. Digital health has been widely adopted in recent years with the intention of improving diabetes treatment and has generated a significant amount of data that could be utilized for additional diabetes management. This has led to the widespread adoption of strategies that make use of artificial intelligence, particularly deep learning, an emerging type of machine learning, with promising outcomes. In this paper, we present an exhaustive survey of the uses of profound advancing inside the field of diabetes. We directed an orderly writing search and recognized three primary regions that utilization this methodology: management of glucose, diabetes diagnosis, and complications of diabetes. We selected 40 original research articles from the search results and have compiled a summary of the most important information about the used learning models, development process, main outcomes, and baseline performance evaluation methods. It should be noted that, in many diabetes-related tasks, various deep learning techniques and frameworks have outperformed conventional machine learning approaches, achieving state-of-the-art performance. In the meantime, we identify some limitations in the existing literature, such as the lack of model interpretability and availability of data. The rapid development of deep learning and the increase in the amount of data that is available make it possible to address these issues in the near future and make it possible for this technology to be widely used in clinical settings.

Keywords— Artificial intelligence, diabetes, deep learning, deep neural networks and managing glucose.

1. Introduction

Techniques like Natural Language Processing (NLP) and Machine Learning have a significant impact on the processing of digital data. Utilizing the value of data in a variety of research areas is essential given the growing reliance on digital data. Separating data from the clinical text can be applied to different applications like programmed phrasing the executives, de-recognizable proof of the clinical text, information mining, recognizable proof of examination subject, forecast of the beginning and progress of various persistent sicknesses, investigation of the illness prescription and its secondary effect, and so forth. In spite of the fact that NLP-based machine learning methods perform better in the fields of biomedicine and healthcare, additional experience in the analysis of narrative clinical text is required [3]. Thusly, it is important to audit the issues seriously what's more, difficulties of separating data from the clinical text to foster new open doors in this field of exploration [4].Natural language processing, bioinformatics, medical informatics, and computer linguistics all fall under the umbrella of biomedical NLP [3]. A significant NLP task that can support decision making, administration reporting, and research is the extraction of useful information from unstructured data embedded in free clinical text. The application of biomedical NLP techniques in electronic health records has a significant impact on numerous areas of biomedical research and healthcare. Medical care related NLP prepared to clinical language handling. The majority of biomedical data is typically unstructured and is the result of direct entry, dictated transcription, or speech recognition applications. Because the summarization and decision-support tasks cannot be performed with the input data in its narrative form, data pre-processing is required for information extraction. Preprocessing incorporates archive structure examination, tokenization, grammatical feature labeling, spell checking, sentence parting, Word Sense Disambiguation (WSD), and some type of parsing. Incorrect interpretation of the extracted data is largely caused by situation-dependent characteristics like event subject identification, temporality, and negation [1]. Rule-based, pattern-matching, machine learning, and statistical techniques, among others, is examples of information extraction methods. The extracted data can then be related to concepts in standard terminologies, improved the electronic health record (EHR) and decision support systems, and used to analyze the clinical text. The applications of natural language processing (NLP) to biomedical and electronic medical record texts and literature are part of the biomedical natural languages processing field. When compared to traditional machine learning (ML) methods, deep learning techniques have recently performed better on a variety of general NLP tasks like language modeling, (Part of Speech) POS tagging, named entity recognition, paraphrase detection, and sentiment analysis. Clinical reports typically face unique challenges when compared to general-domain text because healthcare professionals frequently use acronyms and non-standard clinical terminology, the document's unorganized structure, and the need for complete de-identification and anonymization to safeguard patient data. Clinical decision support, patient engagement support, public health management, pharmacovigilance, medications, and clinical text summarization are just a few of the biomedical applications for which addressing and resolving these issues could eventually spur additional research and advancement.

2. LITERATURE REVIEW

2021. Essam H. Houssein et al. A lot of real-world data is provided by the widespread use of electronic health records (EHR) systems in health care, which opens up new areas for clinical research. Since clinical narratives in electronic health records contain a significant amount of valuable clinical information, natural language processing (NLP) methods have been utilized as an artificial intelligence strategy to extract information from them. However, many clinical data remain hidden in a clinical narrative format in a free-form text like electronic health records. To fully utilize the potential of EHR data to automatically convert a clinical narrative text into structured clinical data, biomedical NLP methods must therefore perform. Biomedical NLP applications can be used to effectively delay or avert disease occurrence, direct clinical decisions, and identify medical issues. The current body of research on the secondary use of data from electronic health records for clinical research on chronic diseases is the subject of this review, which also discusses the potential, difficulties, and applications of biomedical NLP techniques. We go over a few of the biomedical NLP systems and methods that are used on EHRs, as well as a look at the machine learning and deep learning techniques that are used to process EHRs. These techniques make it easier to understand the clinical records of patients and make predictions about the risk of chronic diseases, giving researchers a great opportunity to extract clinical information that was previously unknown. In addition, the use of Deep Learning and Machine Learning in biomedical NLP tasks based on EHR data related to chronic diseases is summarized in this review. At last, this survey presents what's to come patterns and difficulties in the biomedical NLP.

Andreas Lymberis et. al, 2003, Telemedicine has been acquainted with beaten distance to get fast admittance to clinical information and proper medical care. In recent years, telemedicine research has focused on developing solutions to support home care services and the management of chronic diseases like diabetes, lung, and heart conditions. The fields of health promotion and disease prevention, lifestyle management, and well-being are also being entered by telemedicine. The terms "e-health," "telehealth," and "telecare" have emerged as a result of the growth and expansion of telemedicine. Miniaturization and non-invasive smart monitoring of physiological and physical data are made possible by the most recent advancements in information processing and communication technologies, as well as Microsystems and nanotechnologies. Continuous bleeding edge multidisciplinary research in material strands, biomedical sensors, and remote and versatile media communications incorporated with telemedicine, targets creating clever biomedical attire (IBC) that could make ready to help customized administration of wellbeing and illnesses at the point of need and whenever. In this review, we plan to portray the ongoing status of multidisciplinary innovative work of IBC, in light of bibliographic exploration and reports from courses, studios, meetings, and working gatherings. Another objective is to inform developers, decision-makers, and patients in the health and healthcare industries about potential future solutions that will facilitate personalized health care and disease management. Both the material area and medical care area are looking with incredible interest at the creative items and applications that could result from the reconciliation of Microsystems, nanotechnologies, biomedical sensors, materials, and portable broadcast communications. For wellbeing observing, infection anticipation and the board, recovery, furthermore, sport medication, IBC might offer, in the mid-term future, a special, wearable non-prominent telemedicine stage for individualized administrations that is promptly available and of good quality.

U. Rajendra Acharya et. al 2011. Electrocardiogram (ECG) signals are hard to decipher, and clinicians should embrace a long preparation cycle to figure out how to analyze diabetes from unpretentious irregularities in these signs. To work with these determinations, we have fostered a procedure in view of the pulse changeability signal acquired from ECG signals. The detection of diabetes from ECG signals is automated by this method, which makes use of digital signal processing techniques. An analysis method that makes use of these features to diagnose diabetes is described in this paper, along with the signal processing methods that are used to extract features from heart rate (HR) signals. Through measurable examination, we have recognized the connection aspect, Poincare' calculation properties (SD2), and repeat plot properties (REC, DET, Lmean) as helpful elements. These highlights separate the HR information of diabetic patients from those of patients who don't have the ailment, and have been approved by utilizing the AdaBoost classifier with the perceptron powerless student (yielding an order precision of 86%).We then fostered a clever diabetic incorporated file (DII) that is a mix of these nonlinear elements. The DII tells if a particular HR signal was taken from a diabetic. Because of this index, diabetes can be detected automatically, allowing for a more objective evaluation and freeing up medical professionals for other tasks.

Emre Altinkaya et.al, 2020, Many studies have been conducted to examine abnormal conditions in brain structures and to detect Alzheimer's and Dementia states using features derived from medical images. From these data, it is very important to detect the diagnosis of Alzheimer's and Dementia disease early and to provide appropriate treatment to the patients. Quality magnetic resonance (MR) images are requested to make this diagnosis. But while producing a quality image, it also brings less spatial coverage and longer scanning and identification time. In this context, biomedical image processing has undergone a serious expansion and has become an interdisciplinary research field that includes many fields. Computer Aided systems have become an important part in the diagnosis process. With the development of computer aided systems, producing quality information for the diagnosis of disease in image processing applications has caused various problems. Such difficulties are tried to be overcome with artificial intelligence technology and super-resolution (SR), which has gained great importance in image processing lately. Using the super resolution methodology, a high resolution image is obtained from the low resolution image. Thus, the image processing timing is shortened and an image with desired features can be obtained. This shortens the irritating and long-lasting MR imaging process. In addition, it provides convenience for the diagnosis of the disease with the improvements it provides on MR images. Recovering the image is an important step in this process. The quality of the reconstructed image depends on the restoration methods. The functionality of artificial intelligence technology in image processing and biomedical fields is increasing day by day. The deep learning method is preferred in techniques aimed at obtaining a reconstructed quality image. At the same time, various artificial intelligence methods are widely used for classifying and detecting the data obtained. One of the most common of these is neural network (NN) methods. Deep learning, a special method of neural networks, is widely used in classification methods due to its superior structural properties. When studies are examined, it is seen that DL methods are widely used. The success of the proposed methods is increasing day by day.

Berina Alic et. Al, 2017, Using Artificial Neural Networks (ANNs) and Bayesian Networks (BNs), this paper provides an overview of machine learning techniques for the classification of diabetes and cardiovascular diseases (CVDs). The selected papers published between 2008 and 2017 were the subjects of the comparative analysis. In selected papers, the multilayer feedforward neural network with the Levenberg-Marquardt learning algorithm is the type of ANN that is used the most frequently. In contrast, the Naive Bayesian network, which has the highest retrospective accuracy values of 99.51% and 97.92% for diabetes and CVD classification, is the type of BN that is used the most frequently. In addition, using ANN to calculate the mean accuracy of observed networks has produced superior results, indicating a greater likelihood of obtaining more precise diabetes and/or CVD classification results.

Saurabh Pandey et. al, 2017, The goal of data mining is to extract knowledge from data and present it in a form that is simple for humans to compress. It is a method that has been developed for studying enormous amounts of automatically collected data. Computerized reasoning methodology like fluffy, ANN etc are as of now utilized for fixing a wide assortment of issues in unmistakable application region for decision based variant planning. These frameworks allow in us to present the getting to be aware and variety abilities hence such type of structure has been utilized in various novel way of conclusion of illness. It empowers in creating computational worldview that gives a numerical device for managing the vulnerability and the imprecision standard of human thinking. Based on the expertise of the physician, the relationship between diabetes symptoms and risk factors and associated complications or a few common metabolic diseases can result in vision loss, heart failure, stroke, foot ulcer, and nerve damage. The compositional rule of inference can be used to infer the relationship between the signs and symptoms in set S and the diseases in set D in order to diagnose set B of the possible illnesses of the patients. In this work, an overview of the various strategies that are taken into consideration in analysis is provided. It has been discovered that neural networks are appropriate for learning about fuzzy inference rules, membership capabilities, and other context-dependent patterns; Fuzzification expands the applicability of neural networks' capabilities. The core of the automated prognosis system is the classifier. Even though there are numerous uncontrolled variants, the reliable classifier must diagnose the condition with the greatest degree of precision possible. In writing, extraordinary classifiers have been proposed for programmed investigation of PD. For the purpose of automatic PD analysis, the NNs and adaptive neuro fuzzy classifier with linguistic hedges (ANFIS-LH) are investigated. The probabilistic neural community (PNN)'s capacity for automated PD diagnosis is evaluated. The same objective is being pursued for the SVM classifier as well. Some disadvantages of NNs include the need for prolonged training and uncertainty regarding the activation function that can be used in the hidden layer, the number of cells in the hidden layer, and its range. In the case of SVM, the category performance is influenced by the type of kernel function, penalty consistency, and so on. In the event that these boundaries are not properly settled on, the class execution of SVM debases. Likewise, the exhibition of ANFIS relies upon type and boundaries of enrollment trademark and result straight boundaries.

Rasheed Khansa et. al, Researchers are working to make use of the advancements in artificial intelligence (AI) and machine learning (ML) techniques in order to improve clinical practice. Preventive measures that can be implemented as soon as possible are one of the primary goals of healthcare. This is especially true for epilepsy, which is characterized by seizures that come and go without warning. If epileptic seizures can be anticipated in some way, patients may experience relief from their negative effects. Notwithstanding many years of examination, seizure expectation stays a perplexing issue. This is probably going to stay somewhat as a result of the insufficient measure of information to determine the issue. The early and accurate prediction of epileptic seizures could undergo a paradigm shift thanks to exciting new developments in ML-based algorithms. An in depth analysis of the most recent ML methods for the early prediction of seizures based on EEG signals is presented here. We will distinguish the holes, difficulties, and traps in the ebb and flow research and suggest future headings.

According to Taiyu Zhu et al., diabetes is a long-term metabolic condition that affects 463 million people worldwide. Intending to move along the treatment of individuals with diabetes, advanced wellbeing has been broadly took on lately and created a tremendous measure of information that could be utilized for additional administration of this constant infection. Exploiting this, moves toward that utilization fake insight and explicitly profound learning, an arising sort of AI, have been broadly embraced with promising results. We provide a comprehensive overview of the diabetes-related applications of deep learning in this paper. We directed a methodical writing search and distinguished three fundamental regions that utilization this methodology: analysis of diabetes, glucose the executives, and analysis of diabetes-related difficulties. We selected 40 original research articles from the search results and have compiled a summary of the most important information about the used learning models, development process, main outcomes, and baseline performance evaluation methods. It should be noted that, in many diabetes-related tasks, various deep learning techniques and frameworks have outperformed conventional machine learning approaches, achieving state-of the-art performance. In the meantime, we identify some limitations in the existing literature, such as the lack of model interpretability and availability of data. The rapid development of deep learning and the increase in the amount of data that is available make it possible to address these issues in the near future and make it possible for this technology to be widely used in clinical settings.

Liqun Wang et.al, 2008, The target of this commitment is to audit the utilization of cutting edge multivariate information investigation methods in the field of mid-infrared (MIR) spectroscopic biomedical determination. DNA/RNA, proteins, carbohydrates, lipids, and other biomedically relevant constituents can all be found using MIR spectroscopy, a powerful chemical analysis technique. as well as diseases and their progression, all of which have the potential to alter the chemical makeup or structure of biological systems like cells, tissues, and biofluids. However, the complexity of biological samples is usually reflected in the strongly overlapping spectral features in MIR spectra of multiple constituents. As a result, straightforward data-analysis methods frequently struggle to interpret MIR spectra of biological samples. Deconvoluting spectroscopic data and producing useful results from information-rich spectroscopic signals necessitate more complex mathematical and statistical data analysis procedures as the sample matrix becomes more complex. The application of MIR spectroscopy and multivariate data analysis techniques to biomedically relevant fields like cancer detection and analysis, artery diseases, biomarkers, and other pathologies has spawned a substantial body of research. MIR spectroscopy as a screening or diagnostic tool in biomedical research and clinical studies can definitely benefit from more widespread use of multivariate data analysis, as shown by the reported results. The mid-infrared spectral range as a potentially very useful but underutilized frequency region is the focus of this contribution, although the authors do not intend to ignore any relevant contributions to biomedical analysis across the entire electromagnetic spectrum. Without claiming completeness, selected representative examples will demonstrate a variety of biomedical diagnostic applications, with an emphasis on the advantageous relationship between MIR spectroscopy and multivariate data analysis.

2006, Kemal Polat et al. Diabetes occurs when the body is unable to produce insulin, which is required to regulate glucose (sugar), or does not respond appropriately to insulin. Diabetes raises the risk of kidney disease, blindness, nerve damage, and blood vessel damage in addition to contributing to heart disease. In this paper, we have identified on diabetes illness, which is an exceptionally normal and significant sickness utilizing head part investigation (PCA) and versatile neuro-fuzzy deduction framework (ANFIS). Using PCA and ANFIS, this study aims to improve diabetes disease diagnosis accuracy. There are two steps in the proposed system. Principal component analysis is used to reduce the diabetes disease dataset's dimension from 8 features to 4 features in the first stage. In the second stage, determination of diabetes infection is directed through versatile neuro-fluffy deduction framework classifier. We took the diabetes sickness dataset utilized in our review from the UCI (from Division of Data and Software engineering, College of California) Machine Learning Data set. They got characterization precision of our framework was 89.47% and it was extremely encouraging with respect to the other order applications in writing for this issue.

3. METHODOLOGY

3.1 An overview

ANFIS is a fuzzy inference system developed in the 1990s.It can combine the benefits of neural networks with fuzzy logic since it uses both. Its inference method uses fuzzy IF–THEN rules to approximate nonlinear functions. Nonlinear functions can be approximated by this system's learning. ANFIS is considered a universal estimator.

The Adaptive Neural Network Fuzzy Inference System (ANFIS) uses neural networks to make fuzzy inferences based on human knowledge represented as fuzzy if-then rules and approximation membership functions.To fine-tune membership function parameters, ANFIS learning employs least-squares estimation on the output side and back propagation on the input side. The first method is a back propagation of all parameters, which is the steepest descent. The alternative is called hybrid back propagation. This results in less overall training error during the learning process, at least in the immediate context. In a Sugeno-type fuzzy rule basis, the coefficients of the output equation are found using least squares. The training operation will continue until the target number of epochs or RMSE is reached.In this research, we use a hybrid learning approach to define a first-order Takagi-Sugeno fuzzy system and its corresponding parameters. Surface roughness from ball end milling may be predicted using this approach.

Jang [14, 15, and 16] is credited with making the initial suggestion for the Adaptive Neuro Fuzzy Inference System (ANFIS). ANFIS is adaptable enough to handle any input output relationship, and as a result, it may be utilized in a wide variety of real-world contexts. Its use in a variety of fields is something that should be mentioned. When it comes to the classification of data, ANFIS is the first of its kind to be used by NFS. Hybrid model combining ANN and FIS into one capsule. Therefore, once produced, there are no distinctions between ANN and FIS that can be marked out [17].

3.2 Fuzzy Logic

It upholds old style rationale adroitly. It was created by LotfiZadeh [18] in the middle of the 1960s to represent situations in which incorrect data should be used or in which generic inference rules are constructed using dispersed categories [18]. A wide range of truth values exist for logical statements in fuzzy logic, which is also known as diffuse logic. Classical thought, on the other hand, comes to only two conclusions. Reality worth of and is 0.04, yet AC is 0.0. In light of the nullification administrator, the two truth values shouldn't add up to one. Fuzzy logic and probability theory only have a passing connection. Probability is used in fuzzy logic without any prerequisites. This strategy works on multi-esteemed rationale while holding some mathematical construction [18].

Fuzzy logic, which makes use of a geometric model to comprehend the semantics of fuzzy operators, is equivalent to fuzzy set theory. Fluffy rationale can be utilized to decipher brain network models, give a clarification of execution, and indicate networks straightforwardly, dispensing with the requirement for learning calculations. When contrasted with the cycles engaged with preparing a brain organization, the age of control rules for a unique framework by somebody who is a specialist in that specific subject ordinarily requires less exertion. Zadeh used the creation of a system to park a car as a model for the members of the neural network to illustrate his point. Fluffy rationale is being utilized in various items, like business and customer hardware, because of its trouble in making rules and how to prepare it. These items are utilized in circumstances when an adequate framework exists and where the subject of ideal control isn't basic.

Fluffy rationale changes over input information into a fluffy set utilizing factors, words, and enrolment capabilities. A set of rules is then supported by an inference. Utilizing the membership functions, the fuzzy output is transformed into a clear output during the final stage of the defuzzification process.

Algorithms in fuzzy logic:

1. The definition of the language's variables and terms is the focus of initialization.
2. Initialize the functions of the membership.
3. Make the basis for the first rule.
4. Change the input data from hard numbers to fuzzy ones by transforming them with the membership functions (fuzzification).
5. Make an inference based on the evaluations of the rule base.
6. Consolidate the derivations from every one of the standards.

7. Do a defuzzification methodology on the subsequent information.

3.3 Variables in Language

Phonetic factors, which are terms as opposed to any mathematical qualities and might be used as info or result factors in any model, are once in a while alluded to as etymological factors. A set of linguistic words is one of the most common ways to break down a linguistic variable.

As an illustration, consider the air conditioner. The linguistic variable that substitutes for the room's temperature is the temperature, denoted by the letter t. Terms, for example, "hot" and "cold" are involved all through the world for of evaluating temperature. These are the multiple ways that the expression "temperature" might be communicated in various dialects. The notation T (t) then denotes the various subsets of the temperature function variable, which can be read as too cold, cold, warm, hot, or too hot. Every part of this disintegration is alluded to as a semantic word, and conceivable piece of the temperature's qualities will be covered by it.

3.4 Membership Functions

In the FLS fuzzification and defuzzification processes, enrollment capabilities map non-fluffy information words to fluffy language ideas. An enrollment capability is required for the evaluation of a semantic word. A single membership function should not be used to fuzzyify a numerical value because it can belong to multiple sets at the same time, as shown in Figure 3's plot of the linguistic words for the variable temperature as a membership function. A similar temperature value can be both "cold" and "too cold" at the same time, as shown in Figure 3.1, depending on the level of participation.

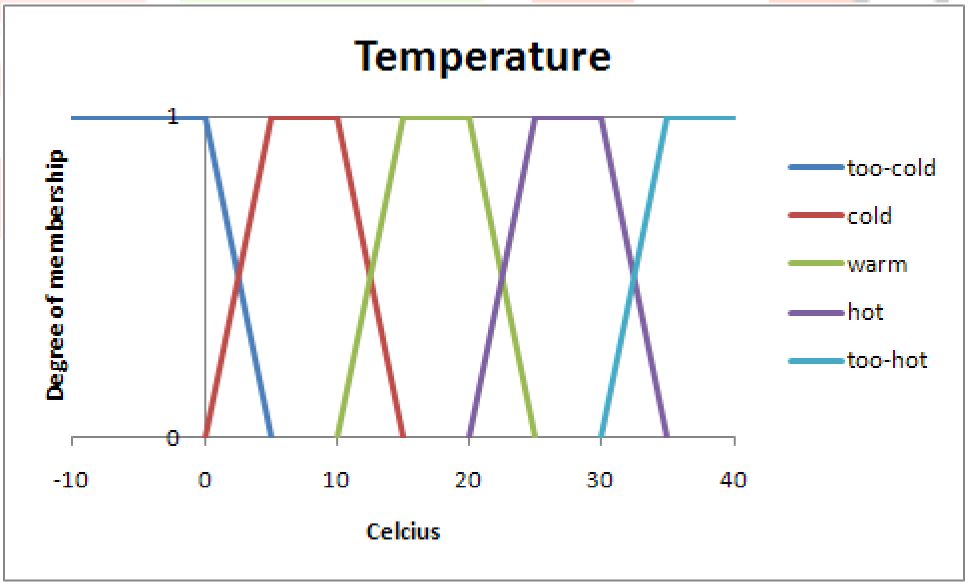

Figure 3.1: T(temperature) = too-cold, cold, warm, hot, and too-hot - Membership Functions.

Participation capabilities can be isolated into different sorts. The most common membership function shapes are the triangular, trapezoidal, and gaussian ones. Although the type of membership function is typically chosen at random based on how it will impact the user experience, context can play a role in this decision.

4. RESULTS AND DISCUSSIONS

Table 4.1: List of significant variables after doing a regression

Id	Regression coef.
4	$5.7516x10^{-005}$
8	0.0010427
3	0.0049116
1	0.024655
7	0.098013
2	0.0038664
5	$4.7833x10^{-005}$
6	0.0041863

Table 4.1 we've seen that inputs 5 and 4 aren't very important, so we can use inputs 2, 6, 3, and 1 to figure out which inputs are most important. Therefore, [1nop;] is the relevant i/p. 2 gconc; 3 bp; 6 bmi; 7 lineage] The most crucial information is that a person's pedigree, number of births, blood pressure, body mass index, and glucose concentration all play a role in determining whether or not they have diabetes. There will be 768 samples in each of the two subsets of the training data set, one for testing and one for training.

5. CONCLUSION

A solid model that accurately reflects diabetes based on the input data is necessary for accurate disease prediction. A strong forecast model and solid location strategy can further develop dynamic infection identification instrument conclusion. If prediction is used, a doctor might come up with biological diagnostics by creating tools that automatically adapt to new situations. Algorithms for long-term prediction have the potential to enhance planning and supply. The majority of research over the past two decades has utilized stochastic processes. Most models utilize stochastic cycles with fewer boundaries. Fitting boundaries to the noticed measurements of a genuine informational collection for the most part brings about models with factual properties like those of the informational index. Like the actual data stream, this kind of model can forecast. Real-time data behaviour can be predicted using stochastic modelling. In an ideal world, such systems would repeat the factual properties of the genuine information. This is not possible due to complexity barriers that may be insurmountable. A crucial objective is to check that a disease's prognosis matches first- and second-order statistics.

REFERENCES

[1] D. Demner-Fushman, W. W. Chapman, and C. J. McDonald, ``what can natural language processing do for clinical decision support?'' J. Biomed. Inform, vol. 42, no. 5, pp. 760_772, 2009.

[2] Essam H. Houssein, Rehab E. Mohamed, and Abdelmgeid A. Ali, "Machine Learning Techniques for Biomedical Natural Language Processing: A Comprehensive Review", 2021

[3] S. A. Hasan and O. Farri, ``Clinical natural language processing with deep learning,'' in Data Science for Healthcare. Springer, 2019, pp. 147_171

[4] G. K. Savova, K. C. Kipper-Schuler, J. F. Hurdle, and S. M. Meystre, ``Extracting information from textual documents in the electronic health record: A review of recent research,'' Yearbook Med. Informat., vol. 17, no. 1, pp. 128_144, 2008.

[5] Andreas Lymberis, Silas Olsson, "Intelligent Biomedical Clothing for Personal Health and Disease Management: State of the Art and Future Vision", 2003

[6] U. Rajendra Acharya, Oliver Faust, S. Vinitha Sree, Dhanjoo N. Ghista, Sumeet Dua, "An integrated diabetic index using heart rate variability signal features for diagnosis of diabetes", ISSN: 1025-5842, (2011)

[7] Berina Alić, Lejla Gurbeta, Almir Badnjević, "Machine Learning Techniques for Classification of Diabetes and Cardiovascular Diseases", MECO'2017, Bar, Montenegro

[8] Saurabh Pandey, Manish Madhava Tripathi, "Diagnosis of Diabetes using Artificial Intelligence Techniques by using Bio Medical Signal Data", ISSN: 2454-6844, 2017

[9] Khansa Rasheed, Adnan Qayyum, Junaid Qadir, Shobi Sivathamboo, Patrick Kwan, "Machine Learning for Predicting Epileptic Seizures Using EEG Signals: A Review"

[10] Taiyu Zhu, Kezhi Li, Pau Herrero, Pantelis Georgiou, "Deep Learning for Diabetes: A Systematic Review"

[11] Liqun Wang, Boris Mizaikoff, "Application of multivariate data-analysis techniques to biomedical diagnostics based on mid-infrared spectroscopy", Anal Bioanal Chem (2008) 391:1641–1654
[12] Kemal Polat, Salih Güne, "An expert system approach based on principal component analysis and adaptive neuro-fuzzy inference system to diagnosis of diabetes disease", (2006)
[13] Emre Altinkaya, Kemal Polat, Burhan Barakli, "Detection of Alzheimer's disease and Dementia States Based on Deep Learning from MRI Images: A Comprehensive Review", ISSN: 2643-8240, (2021)
[14] E. Comak, A. Arslan and T. Ibrahim, "A decision support system based on support vector machines fordiagnosis of the heart valve diseases," Computers in biology and Medicine, vol. 37, pp. 21-27, January 2007.
[15] S. Ghumbre, C. Patil, and A. Ghatol, "Heart disease diagnosis using support vector machine,"International Conference on Computer Science and Information Technology (ICCSIT), pp. 84-88, December 2011.
[16] D. Y. Tsai and S. Watanabe, "Method for optimization of fuzzy reasoning by genetic algorithms and is application to discrimination of myocardial heart disease," IEEE Nuclear Science Symposium and Medico1 Imaging Conference, pp. 2239-2246, December 1966.
[17] E. A. M. Anbarasi and N. Iyengar, "Enhanced prediction of heart disease with feature subset selection using genetic algorithm," International Journal of Engineering Science and Technology, vol. 2, pp. 5370-5376, November 2010.
[18] J. Yang and V. Honavar, "Feature subset selection using a genetic algorithm," IEEE Intelligent Systems,pp. 44-49, March 1998.

.