International Journal of Engineering, Science & Mathematics
Vol. 14 Issue 04, April 2025,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Effective Diagnosis of Diabetes Mellitus for Healthcare System using Supervised Machine Learning Technique

Varun Gupta
Research Scholar (M.Tech ECE, 6th Sem)
Sri Sai University, Palampur (H.P)

Dr. R. P. P. Singh
Dean, Research & Development
Sri Sai University, Palampur (H.P)

Dr. Neeraj Marwaha
Deputy Dean, Engineering
Sri Sai University, Palampur (H.P)

Abstract- Diabetes is a metabolic disorder in which the body is unable to properly regulate blood sugar levels. It can occur when the body does not produce enough insulin or when cells become resistant to insulin's effects. There are two main types of diabetes, Type 1 and Type 2, which have different causes and risk factors. Early detection of diabetes allows for early intervention and management of the condition. This can help prevent or delay the development of serious complications associated with diabetes. Early diagnosis also allows for individuals to make lifestyle changes to prevent the progression of the disease. Healthcare systems play a vital role in the management and treatment of diabetes. They provide access to diabetes education, regular check-ups, and necessary medications for individuals with diabetes. They also provide monitoring and management of diabetes-related complications, such as heart disease, kidney failure, and neuropathy. Through early detection, prevention and management programs, healthcare systems can help improve the quality of life and outcomes for people with diabetes. In this paper the study of ML technique to analysis of DM.

Keywords: Machine Learning (ML), Diabetes Mellitus (DM), Healthcare System (HS)

I. INTRODUCTION

Being healthy is more than just not being sick, hurt or in pain. It is a person's whole well-being across all dimensions. Health is described as "a state of complete physical, mental and social well-being and not merely absence of disease" by World Health Organization [1]."Hale" (strength) and "hoelth"(sound) are roots of word "health". A person is deemed healthy if they are able to perform normally adjust to changes in their surroundings and feel well. According to contemporary scientific theory various elements in biological environment, psychological state and social context have the ability to influence any sickness. Physical fitness is result of exercise, balanced diet, nutrition regular cleanliness and enough sleep. According to psychological definition "Health is a state of well-being in which the individual can work effectively and productively, realize his or her own potential and cope with normal stresses of life". Human biology, lifestyle, healthcare services and environment are determinants of health. Advances in healthcare are not only factors that preserve and improve health, society and personal lifestyle choices also play a significant role.

Good health habits often lead to a longer and more fulfilling life, providing opportunity to spend more time with loved ones and pursue personal goals. Good health can lower medical expenses and reduce economic burden on individuals, families and societies caused by healthcare costs. Investing in health through balanced nutrition, regular exercise, sufficient sleep, stress management and preventive healthcare measures is essential for overall well-being. It is about a lifestyle that prioritizes and sustains good health across all facets of life. Diabetes is becoming a more common worldwide to life especially in developing countries and it is one of disease that causes impairment and death. Diabetes is a chronic condition in which a person has higher blood glucose levels as a result of insufficient insulin levels in body cells. Food consumption is converted into energy during metabolic activity by the hormone insulin which accomplishes by converting sugars into energy. It involves several organs, including eyes, kidneys, nerves, heart and veins are linked to the stable glucose of diabetes [2, 3].

Numerous other factors including an unhealthy lifestyle, inactivity, smoking, high cholesterol and high blood pressure can significantly raise the chance of diabetes. Diabetes affects individuals of all ages from children to elderly. Different people have different diagnoses of diabetes. Some need merely a change in lifestyle while others need medical care which may include medications, insulin injections and healthier lifestyle choices to maintain blood sugar levels. Features of association identification and classification have been suggested to be combined. For obtaining an appropriate diabetes diagnosis combination of association rule development and classification is highly useful [4, 5] because they perform better in predicting Diabetes.

II. DIABETES MELLITUS

Diabetes falls under the category of metabolic diseases defined by hyperglycemia occurring due to imperfections in insulin

International Journal of Engineering, Science & Mathematics
Vol. 14 Issue 04, April 2025,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

emission, insulin activity, or the two of them. The ongoing hyperglycemia of diabetes is related with long haul harm, brokenness, and disappointment of different organs, especially the eyes, kidneys, nerves, heart, and veins [6, 7]. There are different pathogenic cycles engaged with the spread of diabetes. These beginning from immune system harm to the pancreatic b-cells and the later ensuing insulin shortfall to anomalies bringing about protection from insulin activity as shown in Fig. 1.

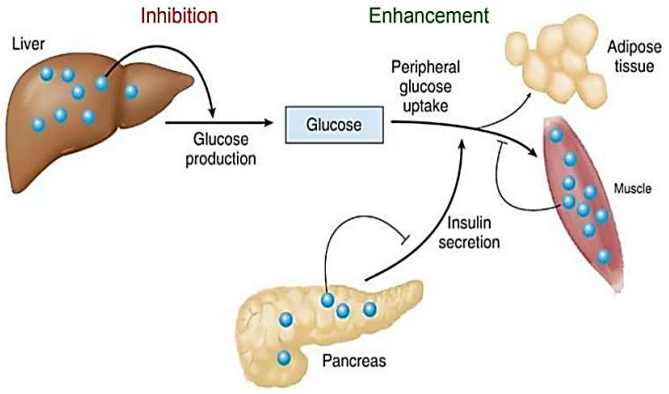

Fig. 1: Effects of Insulin on Blood Glucose (Liver, Muscle, Fat)

The peculiarities springing in sugar, fat, and protein assimilation in diabetes results in light of the deficiency movement of insulin over the assigned tissues. The deficit in insulin action is a result of the lacking insulin release as well as reduced tissue responses to insulin at one or better places in the cutting edge pathways of compound movement. Brokenness in the insulin release and irregularities in insulin activity frequently are seen together in a similar patient, and there is by and large no clearness on which brokenness, if either alone, is the main driver behind the hyperglycemia [8].

In the non-oversaw state, the two sorts of diabetes portray an ascent in hepatic glucose yield and diminished glucose take-up in the muscles and fat tissue. Patients encountering type 1 diabetes are at a gamble of certified lipolysis achieving diabetic ketoacidosis [9]. The rest of the insulin development in type 2 diabetes overall upsets lipolysis and ketone age so that these patients are less right now be impacted with ketoacidosis yet can go to a hyperosmolar, non-ketotic state.

2.1 Symptoms of DM

Checked hyperglycemia shows side effects like polyuria, polydipsia, weight reduction, polyphagia, and foggy vision. Persistent hyperglycemia may likewise be joined by a decrease in development and weakness to a couple of contaminations. Intense, life-harming consequences of uncontrolled diabetes consolidate hyperglycemia with ketoacidosis or the nonketotic hyperosmolar jumble [10]. Long-range troubles of diabetes are retinopathy with likely vision disaster, nephropathy achieving renal frustration, periphery neuropathy with the gamble of foot ulcers, expulsions, and Charcot's joints, and autonomic neuropathy occurring in gastrointestinal, genitourinary, and cardiovascular secondary effects and sexual brokenness. Patients encountering diabetes show a rising in the start of atherosclerotic cardiovascular, periphery vein, and cerebrovascular disease. Hypertension and brokenness of lipoprotein processing are constantly found in individuals affected with diabetes.

Table 1: Symptoms and Treatment of Diabetes

Diabetes	Symptoms	Treatment
Type 1	Increase in thirst, frequent urination, massive hunger, hazy vision, unknown weight loss.	Insulin intake, carbohydrate, fat and protein count counting, frequent blood sugar monitoring, consumption of healthy foods.
Type 2	Obesity (specified by a body mass index higher than thirty), absence of physical activity, improper diet, stress patches of dark skin and urbanization	Metformin (Glucophage, Glumetza), Sulfonylureas, meglitinides, thiazolidinediones

Other Diabetes Mellitus Types (Monogenic Types): It focuses on endocrinopathies, LADA, and MODY. It is also brought on by genetic anomalies in the hormone insulin's internal secretion.One to five percent of those who have experienced it go on to get mutations.

This covers pancreatic disorders, specific surgeries, beta cell genetic flaws, cancer treatments, drugs and infections, etc. Certain medications are used in conjunction with HIV/AIDS treatment transplanting organs [16]. It has subtypes.

LADA, Endocrinopathies, and MOODY.

MODY: Insulin may or may not be necessary for them. MODY represents diabetes of young people with maturity onset [9]. MODY is a genetically inherited form of diabetes mellitus alteration in a gene that is autosomal dominant and impacts the generation or secretion of insulin and is not an insulin-dependent form of diabetes. Children typically receive fewer individual diagnoses than age 25 due to hereditary reasons. About 70% of cases are caused by the HNF1-Alpha (hepatocyte nuclear factor) gene. of MODY [17]. It is linked to a genetic flaw in the β-cells. This kind involves hyperglycemia at an young age. Clinically, they resemble type 2 diabetes.

LADA: Latent autoimmune diabetes is referred to as LADA in adults. Insulin is not necessary after diagnosis throughout several months to a year. They do not generate any insulin, and

it shares clinical similarities with LADA and T1DM. happens as a result of the pancreatic cells ceasing to produce insulin. Because of age, LADA can be mistaken for type 2 diabetes mellitus and occurs in young individuals in their twenties [18]. Type 1 diabetes differs from LADA (Table 2).

Table 2: Difference parameters of DM

	T1DM	T2DM	MODY	LADA
Typical Age of Onset	Youth	Adult	Youth	Adult
Presence of Autoantibodies	Yes	No	No	Yes
Insulin Dependence	Yes	No	Not Always	Yes, within years
Insulin Resistance	No	Yes	Yes	No
Progression to Insulin Dependence	Rapid	Slow	Slow	Month/Year

III. ML FOR MEDICAL DIAGNOSIS

Disease ID and examination of ailments is at the front of AI research in medicine. Computer based intelligence and computational information systems might conceivably change clinical consideration by giving objective decision assist gadgets with aiding clinical specialists in finding and perception of patient conditions. The usage of artificial intelligence in starter (starting stage) drug disclosure has the potential for various purposes, from early on screening of prescription gathers to expected accomplishment rate considering natural factors [11].

Actually there has been growing interest in the use of computer based intelligence in both clinical imaging and model affirmation for PC upheld assurance. State of-theart plan affirmation and man-made intelligence methodologies like significant cerebrum associations, and mixes of made due, semi controlled and independent learning strategies, are continuously being used to handle issues in clinical picture assessment, clinical end and examination of biomarkers. In any case, computer based intelligence in clinical benefits informatics presents numerous troubles to simulated intelligence experts, including high layered feature vectors, limited model sizes, perplexing and related patient components and the once in a while deficiently got a handle on associations between grasping features and the last end/representation. Game plan structures have been extensively utilized in clinical space to look at and show patient's data and concentrate a farsighted model. They help specialists with chipping away at their conjecture, assurance or treatment organizing techniques [12].

The execution of artificial intelligence will chip away at indicative precision. Another Foundation of Clinical report highlighted the upsetting repeat of suggestive missteps and the shortfall of interventions to lessen them. Estimations will in a little while produce differential ends, propose high-regard tests and decrease the testing dataset. Simulated intelligence computations capability commendably on the off chance that there ought to emerge an event of datasets size is really tremendous. Clinical route is significantly fitting for rule-put together structures with respect to record of the possibility of the data, as ICD-9 codes, drugs, etc, which are discrete fields (For Instance Boolean in the Electronic Clinical record). A good clinical decision relies upon data eliminated from heterogeneous data sources, for instance, coordinated data [diagnosis codes, system codes, medications] unstructured data, (clinical notes) picture data (x-radiates) [13, 14].

IV. LITERATURE REVIEW

The rising incidence of diabetes mellitus (DM) in the contemporary healthcare environment has presented serious public health issues, especially Type 2 diabetes (T2D), which is mostly preventable but frequently goes undetected until problems develop. Researchers are increasingly using machine learning (ML) and deep learning (DL) approaches to create prediction models that can help with the early diagnosis, prognosis, and efficient management of diabetes because traditional diagnostic methods are still slow and limited in their scalability. In addition to improving diagnosis precision, these AI-powered methods provide widespread screening in clinical and distant health monitoring contexts. Preprocessing methods, feature selection, classification algorithms, and explainability frameworks are just a few of the models, approaches, and tools being used to address diabetes prediction, according to a review of recent literature.

A strong intelligent healthcare system that uses a variety of machine learning classifiers to automate diabetes diagnosis and prediction was provided by Iqra Nissara et al. [1]. In this work, classifiers like support vector machines (SVM), decision trees, and ensemble approaches were applied to structured medical information. They underlined how crucial precision and a shorter diagnosis delay are in clinical settings. By providing a scalable and trustworthy diagnostic tool, their system not only improved the accuracy of diabetes prediction but also demonstrated how AI may lessen the strain for medical practitioners. Saini, Guleria, and Sharma [2] compared several machine learning algorithms for diabetes prediction in a different study. Using performance criteria including accuracy, precision, and F1-score, they assessed models such as logistic regression, K-nearest neighbors (KNN), and Naive Bayes. The study found that feature selection and preprocessing choices had a major impact on results, even though no single model predominated across all metrics. The study acts as a manual for selecting suitable machine learning models according to particular data properties. Using a multiclass classification framework, Guleria et al. [3] expanded the use of ML and DL

beyond diabetes to the diagnosis of hypothyroidism. Their research focused on the enhanced accuracy and generalization of hybrid systems by combining both conventional machine learning (ML) methods with deep learning models such as convolutional neural networks (CNNs). Despite being centered on hypothyroidism, the architecture and methods used have a lot in common with diabetes prediction, particularly when it comes to managing nonlinear, multi-feature medical datasets. Kaur and Kumari [4] addressed predictive modeling for diabetes using data analytics and ML techniques. Their approach involved extensive preprocessing and the application of algorithms like random forests and gradient boosting. The study highlighted the significance of explainability in healthcare ML models, suggesting that models offering insights into their decision-making process are more useful in clinical practice. Interpretability, they argued, is key to clinician trust and real-world adoption. Isfafuzzaman Tasin et al. [5] further advanced the field by incorporating explainable AI (XAI) techniques alongside ML models for diabetes prediction. Their study, published in *Healthcare Technology Letters*, combined classification models with explainability frameworks like SHAP (SHapley Additive exPlanations) and LIME (Local Interpretable Model-agnostic Explanations). This enabled clinicians to not only rely on predictions but also understand the influence of specific features (e.g., BMI, glucose level) on outcomes. Their research reinforced the importance of transparent AI systems in healthcare, which can provide actionable insights and increase user confidence. Olisah, Smith, and Smith [6] contributed a detailed review on diabetes prediction from the perspective of data preprocessing and ML modeling. Their analysis emphasized the critical role of data cleaning, normalization, and outlier removal in improving model performance. The study also explored feature engineering techniques and their impact on reducing dimensionality while preserving predictive power. This work underscores that predictive accuracy is not solely dependent on the algorithm used, but also on how well the data is curated and structured.

Deberneh and Kim [7] explored the application of various ML algorithms in predicting Type 2 diabetes, using publicly available datasets such as PIMA. Their study tested decision trees, SVMs, and ensemble models, finding that ensemble approaches often yielded higher accuracy and robustness. The research further stressed the importance of cross-validation and hyperparameter tuning to avoid overfitting and improve model generalization, especially in real-world deployment.

Nikos Fazakis et al. [8] created machine learning methods with the express purpose of predicting Type 2 diabetes risk over the long run. Longitudinal data and sophisticated modeling methods, such as random forests and gradient-boosted trees, were employed in their work. Their study's ability to forecast diabetes risk years in advance, opening up a window for early intervention, was a major contribution. Predictive modeling's capacity for prevention was demonstrated when the models were trained to recognize at-risk individuals using past health data. A real-world application of machine learning classification methods for diabetes prediction was carried out by Naveen Kishore G et al. [9]. They evaluated models on datasets using confusion matrix metrics, including SVM, decision trees, and KNN. Their study highlighted the significance of balanced datasets for obtaining objective predictions and showed the relative ease of use and efficacy of baseline models. Additionally, they promoted integration with hospital information systems for real-time implementation.

Last but not least, Chatrati, Hossain, and Goyal [10] suggested a smart home health monitoring system that predicts diabetes and hypertension by fusing Internet of Things (IoT) sensors with machine learning algorithms. Their system gathers physiological data in real time, such as blood pressure and glucose levels, and using predictive analytics to notify consumers and medical professionals. This strategy is in line with the future of telehealth and personalized care since it moves away from centralized hospital diagnostics and toward ongoing monitoring at home.

Collectively, these ten studies present a comprehensive view of how ML and DL are revolutionizing diabetes diagnosis and healthcare analytics. Key themes emerging from the literature include:

- **Model diversity and performance trade-offs**: No single algorithm is universally best; model selection must consider dataset characteristics, interpretability, and application context.
- **Importance of preprocessing**: Proper data preparation, including normalization and feature selection, is foundational to model success.
- **Explainable AI (XAI)**: As predictive models enter clinical workflows, transparency and interpretability are essential for clinician acceptance.
- **Hybrid and ensemble methods**: Combining multiple algorithms often yields better performance by capturing diverse data patterns.
- **Real-time and smart systems**: IoT integration enables continuous monitoring, allowing early detection and timely interventions outside traditional healthcare facilities.

In conclusion, the integration of ML and DL in diabetes prediction presents a transformative opportunity for healthcare systems worldwide. From algorithm development and comparative evaluation to smart systems deployment, the field continues to evolve rapidly, driven by technological advances and the pressing need for scalable, accurate, and interpretable diagnostic tools. The collective findings from these studies not

only affirm the viability of AI in healthcare but also lay the groundwork for future research that bridges technical innovation with real-world medical applications.

Table 3: Summary of Literature Review

S. No.	Title	Authors	Year	Source	Main Focus / Techniques Used
1	An Intelligent Healthcare System for Automated Diabetes Diagnosis and Prediction using Machine Learning	Iqra Nissar, W.A. Mir, T.A. Shaikh, T. Areen, M. Kashif, S. Khiani, A. Hussain	2024	Science Direct, Vol. 235, pp. 2476–2485	ML-based intelligent healthcare system for diabetes prediction
2	Predictive Machine Learning Techniques for Diabetes Detection: An Analytical Comparison	A. Saini, K. Guleria, S. Sharma	2023	IEEE DELCON Conference	Comparative analysis of ML techniques for diabetes detection
3	Early prediction of hypothyroidism and multiclass classification using predictive machine learning and deep learning	K. Guleria, S. Sharma, S. Kumar, S. Tiwari	2022	Measurement: Sensors (24):100482	Early detection of hypothyroidism using ML/DL
4	Predictive modelling and analytics for diabetes using a machine learning approach	H. Kaur, V. Kumari	2022	Applied Computing and Informatics, 18(1/2):90–100	Predictive ML modeling and analytics for diabetes
5	Diabetes prediction using machine learning and explainable AI techniques	I. Tasin, T.U. Nabil, S. Islam, R. Khan	2022	Healthcare Technology Letters, Wiley, pp. 01–10	ML with explainable AI for diabetes prediction
6	Diabetes mellitus prediction and diagnosis from a data preprocessing and machine learning perspective	C.C. Olisah, L. Smith, M. Smith	2022	Comput. Methods Programs Biomed., Vol. 20, pp. 1–12	Focus on data preprocessing and ML for diabetes diagnosis
7	Prediction of type 2 diabetes based on machine learning algorithm	H.M. Deberneh, I. Kim	2021	Int. J. Environ. Res. Public Health, Vol. 18, pp. 1–14	ML-based prediction of type 2 diabetes

V. METHODOLOGY

ML procedure has been a great help for making expectation of a specific framework via preparing. ML is tied in with gaining structures from the information which is given. ML as of late have been the developing, dependable and supporting instrument in clinical area [15].

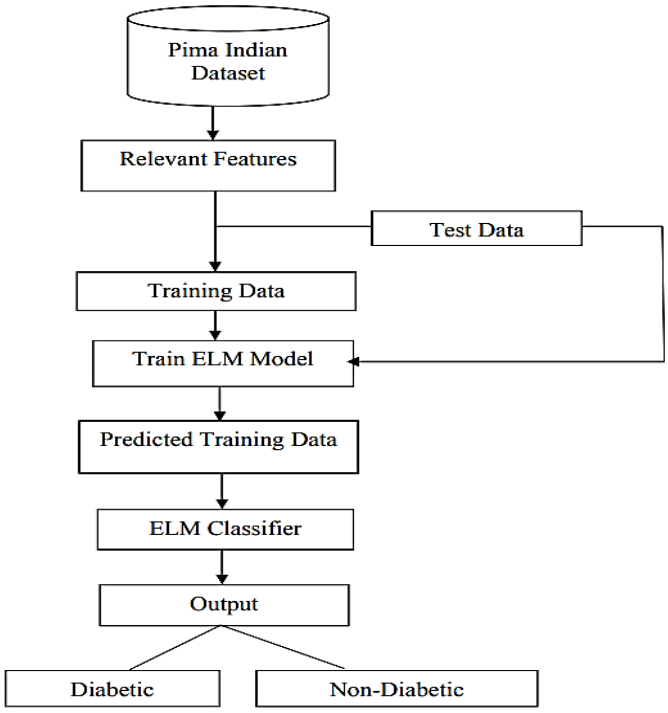

Fig. 2: ELM Prediction

Programmed learning has brought a more noteworthy measure of interest in clinical area because of less measure of time for location and less cooperation with patient, saving time for patients care. AI has offered most noteworthy help for anticipating illness with right instance of preparing and testing. Diabetes needs most noteworthy help of AI to identify diabetes sickness in beginning phase, since it can't be restored and furthermore carries extraordinary entanglement to our wellbeing framework. One of the promising procedures in AI is SVM and Extreme Learning Machine (ELM).

A framework is created which identifies diabetes mellitus and revels about the confusions because of diabetes. Arrangement of diabetes mellitus infection as diabetes and non-diabetes is finished utilizing SVM. The vitally difficult assignment for a framework is to acquire a dataset. Trait determination need more worried for getting definite level of productivity. The standard dataset got from Pima diabetes information base is utilized for recognizing proposed framework. The informational collection contains information for 769 patients contains both wiped out and sound patient's information are acquired. The datasets are put away in succeed design for preprocessing the information.

VI. CONCLUSION

This paper has presented research in ML classifiers for prediction of DM. DM is one of the normal and quickly expanding infections on the planet. It is a significant medical issue in the majority of the nations. Recognition and finding of diabetes at a beginning phase is obligatory and translation of the diabetes information is a significant grouping issue. Thusly, various exploration works have been directed to dissect and arrange the DM patient sorts. In this exploration, a few ML models have been carried out to anticipate and order diabetes types. This classifier endeavored to tackle three issues, for example, classifying patients regarding diabetic sorts, precision and to foresee a diabetic and non-diabetic.

REFRENCES

[1] Iqra Nissara , Waseem Ahmad Mirb, Tawseef Ayoub Shaikh, Tuba Areend, Mohammad Kashif, Simran Khiani and Asif Hussaine, "An Intelligent Healthcare System for Automated Diabetes Diagnosis and Prediction using Machine Learning", Science Direct, vol. 235, pp. 2476-2485, 2024.

[2] Saini A, Guleria K, Sharma S., "Predictive Machine Learning Techniques for Diabetes Detection: An Analytical Comparison", In2023 2nd Edition of IEEE Delhi Section Flagship Conference (DELCON):1-5, 2023.

[3] Guleria K, Sharma S, Kumar S, Tiwari S., "Early prediction of hypothyroidism and multiclass classification using predictive machine learning and deep learning." Measurement: Sensors (24):100482, 2022.

[4] Kaur H, Kumari V., "Predictive modelling and analytics for diabetes using a machine learning approach", Applied computing and informatics, 18(1/2):90-100, 2022.

[5] Isfafuzzaman Tasin, Tansin Ullah Nabil, Sanjida Islam, Riasat Khan, "Diabetes prediction using machine learning and explainable AI techniques", Healthcare Technology Letters, pp. 01-10, Wiley 2022.

[6] Olisah, C.C., Smith, L., Smith, M., "Diabetes mellitus prediction and diagnosis from a data preprocessing and machine learning perspective", Comput. Methods Programs Biomed., Vol. 20, pp. 1–12, 2022.

[7] Deberneh, H.M., Kim, I., "Prediction of type 2 diabetes based on machine learning algorithm", Int. J. Environ. Res. Public Health, Vol. 18, pp. 1–14, 2021.

[8] Nikos Fazakis, Otilia Kocsis, Elias Dritsas, Sotiris Alexiou, Nikos Fakotakis, and Konstantinos Moustakas, "Machine Learning Tools for Long-Term Type 2 Diabetes Risk Prediction", IEEE Access 2021.

[9] Naveen Kishore G, V.Rajesh, A.Vamsi Akki Reddy, K.Sumedh, T.Rajesh Sai Reddy, "Prediction of Diabetes using Machine Learning Classification Algorithms", International Journal of Scientific & Technology Research, Vol. 9, No. 01, 2020.

[10] Chatrati, S.P., Hossain, G., Goyal, A., "Smart home health monitoring system for predicting type 2 diabetes and hypertension", J. King Saud Univ. Comput. Inf. Sci., Vol. 34, No. 3, pp. 862–870, 2020.

[11] Hasan, M.K., Alam, M.A., Das, D., Hossain, E., Hasan, M., "Diabetes prediction using ensembling of different machine learning classifiers", IEEE Access, Vol. 8, pp. 76516–76531, 2020.

[12] Cervantes, J., García-Lamont, F., Rodríguez, L., Lopez-Chau, A., "A comprehensive survey on support vector machine classification: Applications, challenges and trends", Neurocomputing, Vol. 408, pp. 189–215, 2020.

[13] Pranto, B., "Evaluating machine learning methods for predicting diabetes among female patients in Bangladesh", Information Vol. 11, pp. 1–20, 2020.

[14] Mohan, N., Jain, V., "Performance analysis of support vector machine in diabetes prediction", In: International Conference on Electronics, Communication and Aerospace Technology, pp. 1–3, 2020.

[15] Muhammad Azeem Sarwar, 2Nasir Kamal, 3Wajeeha Hamid,4Munam Ali Shah, "Prediction of Diabetes Using Machine Learning Algorithms in Healthcare", 24th International Conference on Automation & Computing, Newcastle University, Newcastle upon Tyne, UK, 6-7 September 2019.

[16] Rao G.A., Syamala K., Kishore P.V.V., Sastry A.S.C.S. ., "Deep convolutional neural networks for sign language recognition", International Journal of Engineering and Technology(UAE) ,Vol: 7, Issue 5, pp: 62-70, 2018.