Internet of Things and Cloud Computing
2021; 9(4): 27-32
http://www.sciencepublishinggroup.com/j/iotcc
doi: 10.11648/j.iotcc.20210904.11
ISSN: 2376-7715 (Print); ISSN: 2376-7731 (Online)

Smart Village Health System IoT to Envisage Chronical Disease Using Artificial Neural Network

Muhammad Yousif[1], Akifa Abbas[2], Zahid Hasan[1], Danish Ali[1], Muhammad Sarfraz[1]

[1]School of Computer Science, National College of Business Administration and Economics, Lahore, Pakistan

[2]Department of Computer Science, Lahore Garrison University, Lahore, Pakistan

Email address:

engineeryousif@hotmail.com (M. Yousif), akifaabbas@lgu.edu.pk (A. Abbas), zahidhasan@gmail.com (Z. hasan), csdanishali@gmail.com (D. Ali), sarfrazmoor@gmail.com (M. Sarfraz)

To cite this article:

Muhammad Yousif, Akifa Abbas, Zahid Hasan, Danish Ali, Muhammad Sarfraz. Smart Village Health System IoT to Envisage Chronical Disease Using Artificial Neural Network. *Internet of Things and Cloud Computing.* Vol. 9, No. 4, 2021, pp. 27-32. doi: 10.11648/j.iotcc.20210904.11

Received: January 12, 2021; **Accepted**: December 21, 2021; **Published**: MM DD, 2021

Abstract: A Smart Village Health System (SVHS) understands the infrastructure, facilities, and schemes open to its villager. The Internet of Things (IoT) transforms a village health system into an SVHS using ANN that includes schools, highways, environment, and globalization. It has been designed with the intension to provide basic healthcare facilities to the inhabitant. It also gives information about the chronic diseases by employing Artificial Neural Network (ANN). A SVHS model based on HCV dataset is proposed in this paper. The system is built with cloud and IoT to enable data by means of the patient's input parameters to be collected, indexed and visualized in a smart village. The Levenberg-Marquardt (LM), Bayesian Regularization (BR) and the Scale Conjugate Gradient (SCG) algorithms are implemented with ANN-based approach named as " IoT enabled Smart Village Health System to Predict Chronical Disease empowered with Artificial Neural Network (ToVHS)" in order to develop an efficient and smart CHP model. The evaluation of the proposed method indicates that the SCG algorithm achieves promising results with respect to accuracy and miss rates. The predicted accuracy of the proposed model shows 90.39% performance of CHP on the given factors.

Keywords: SVHS (Smart Village Health System), IoT (Internet of Things), CHP (Chronical Health Prediction)

1. Introduction

Modernization and urbanization mean that people move for multiple services from one location to another, such as schooling, healthcare, transportation, the cleaner environment, and human globalization. The village is the principal criterion for the nation's development. Thus, develop the village so that it relies on its services, jobs and is connected well with the rest of the world, that is, smart village. The smart village adjusts societal control by offering housing for healthy family relations without distorting the various generations ' lifestyles [1]. The dream of the smart village is that modern access to power will act as a catalyst for schooling, infrastructure, road transport, the clean environment and sustainable globalization and for participatory democracy that can contribute to further boost energy access. The term for the development of the village was at the start [2]. But it's recently called a smart village. The government also puts a strong focus on the smart village every day. The government is implementing so many smart villages schemes. The main goals of this research are:

1. To recognize the absence of important research facilities.
2. Formulation of design approaches for smart village growth.
3. To grow the village as a smart village by following guidelines and techniques.

Over recent years, smart healthcare has gained tremendous exposure. A network of smart health services has recently been disclosed with the proliferation of IoT, mobile, and cloud-based technology [3-6], Fuzzy based projects [7-9], Frameworks [10], and studies [11-13]. Through smart healthcare, citizens and patients in a community play a major role in their own healthcare by communicating with Smart City (SC) stakeholders through smart communication, sensors and other integrated devices. In this citizen-centered smart healthcare system employees will connect throughout real-time, on an ad-hoc basis, health data for research and future SC planning [14-16].

SV is the revolutionary philosophy to sharpen a smart and healthier lifestyle by enacting the development of modern technology. SV subjugates the neural network and the information automation for optimal use of public resources increases the quality of services provided to the villagers and decreases operating costs. SV's vision presents villagers with schooling, health, roads, globalization and a clean environment. In administration as well as development of public services in education, health, road, globalization and clean environments, etc., the SV idea ushered many benefits [17, 18]. SV villagers continue installing major facilities, such as educational facilities, health facilities and if a village has all these amenities the village is said to be smart [19, 20]. Several villages are under construction, where there are no colleges, health facilities and highways. Such facilities must be enhanced, SV also plays a vital role in globalization.

Smart Villages are rural communities that use innovative solutions to boost their resources and prospects at the local level. They are based on a participatory approach in the development and implementation of their economic social and/or environmental policy to improve their conditions through the mobilization of digital technology solutions [21, 22]. Smart villagers benefit from alliances with other rural and urban societies and actors. Smart Village plans can be applied and developed based on current policies and can be sponsored from a variety of public and private outlets.

Chronic hepatitis C virus (HCV) is the infection of more than 73 million people around the world that leads to important diseases and deaths, mainly due to cirrhosis, liver fibrosis, and liver cancer. Further, the extra-hepatic appearance is frequently seen in chronically infected people such as mixed vasculitis associated with cryoglobulinemia including renal disease and diabetes type II. HCV therapy eliminates the infection to completely eradicate all extra-hepatic and liver symptoms. New combinations in multiple drug production stages provide solutions supply limited treatment of patients who refuse to endure therapy with latest DAAs with significant hepatic and renal chronic conditions [20].

2. Literature Review

The smart transport system has a significant impact on SC according to this study, while outdated systems do not have the ability to handle the nearby signals spontaneously in order to alleviate and control traffic congestion utilizing neural Networks. Multi-sensors that capture, exchange traffic data and send it to the controller using IoT controlled devices on several adjacent signals. Moreover, this research provided better observations than the time series of the ANN [1]. This research indicated that the SC plays an essential role in urban network operations utilizing IoT tools.

The Air Quality Index (AQI) and Machine Learning (ML) techniques such as ANN, SVM, and multiclass SVM were observed in this analysis and got correct results using ML. The SVM was found to be more stable and effective [23, 24]. Deep learning methods have been used in this work in advanced healthcare applications. The traditional concept of artificial neural networks, which has grown with the arrival of increased computational power and the integration of wireless communication technologies, has emerged also in scope of learning techniques.

In this research, the major approaches of deep learning were explored using its strategies throughout E-Health, which included deep feed-forward networks, autoencoders, convolutional neural networks, deep perception networks, Boltzmann computers and Boltzmann system [25, 26]. In fact, different methods, such as wearables, demos and crowd-sensing, have been implemented. The study also connected deep learning technologies explored in the scrutiny of medical sensory data with current cases of use. The research classified sensory data procurement approaches based on existing data production technology in order to provide a thorough understanding of these linkages. argued that the clever fitness structures that covered sensors and actuators, as well as the current, deep learning methods for the successful processing of sensory data visited specific applications [3, 24].

This study explained how the implementation of SVs in rural and urban environments is needed to better live and demonstrates that SV’s improve the country's grassroots level. This research also established an effective rural system for science, technological, regulatory and management applications, which play a vital role in the emergence of new generation of SV. This complex problem can have a crucial role in developing SVs, as shown by the Public-Private Partnership (PPP). The SV's results were supposed to be outstanding. In other developing world nations, the SV model had a strong replication capacity. The SV definition can also be broadened to include small cities and townships in the field of big cities [4].

This research explains that the SV model can be built in order to increase the number of self-supporting villagers as an alternative model for village sustainability. This research encompasses five dimensions, i.e. (1) Assets, (2) Technologies, (3) Service Chain, (4) organization, and (5) Support which include several metrics and four phases in advancement. This work is still philosophically established, and research into this system based on village control, such as environment SV, a smart agriculture village, a smart tourist village, and so forth, needs to be continued. However, a measurement model for the integration of SVs in Indonesia that is integrated with VBI must also be developed [5].

Such research showed, through the way of technological development and digitalization, quelling the problems arising from the social and cultural, but also from the broader changes in people's societies. A comparative evaluation of programs and initiatives was one of the study goals. Taking account of globally involved projects, they contrasted the regions they surveyed and concluded that exposure to the energy sources is the most critical issue to tackle when developing strategies of the so-called undeveloped countries. In the light of the assessment of projects and programs based on the criteria which determine "smart development" in its broader sense within the EU policies, the Smart Villages definition will be more open and useful. It was important to analyze in-depth the various ways in which the European regions could be interpreted. Below is a quick review of the EU Smart Villages pillars/drivers [6]:

1. The reaction of demographic transition and eradication.
2. Regional options are found.
3. Exploring links with cities and towns.
4. Speed up rural areas ' position in low-carbon circulatory economies.
5. Encourage digital transition.

In a sustainable development strategy was actively used that influenced the local mining community and entered the regional strategic plan. Using the Fuzzy-Delphi approach to fulfill the efficiency demands of this plan The Vice President of Cultural Patrimony and Sustainable Development assessed the success prediction [7].

In The Kelvin Grove Urban Village (KGUV) addressed the basic principles of modern urbanization, social diversity and the creation of a wide range of designs. Such results have two implications: firstly: that community planners take the findings into consideration during their inquiry into "location influences" on health and, secondly, that health communicators take further notice of the environmental characteristics that are used before the conception and delivery of communications and strategies to promote health [10].

In there were no interdisciplinary strategies to improve health and an HCI architecture approach to healthy social environments and complexities in developed communities was addressed. The authors explored the design of ROOT, an adaptive lighting system that facilitates walking and social interaction. This study found that the creative and collaborative nature of a hackathon allows the quick exchange of opinions in urban design and interdisciplinary research [11].

In an intelligent health solution in a SC was proposed and included an automated VPD system. The approach took two forms of input signals: voice and EGG, which were inherent. Cloud derives local features from the voice signal and the form and cepstral properties of the EGG signal. The GMM classifier makes a choice on the identification of diseases using these functions. The outcome was then passed on to licensed doctors who then act accordingly [12].

In the recent time, various research problems have been correlated by authorized surviving Evolutionary algorithms [27, 28], Swarm Intelligence [29, 30], Neural Network and Fuzzy Systems [25, 31, 32] that have newly been included, yet additionally some new methodologies. This opened some other period for the researchers.

3. Proposed IoT Enabled Smart Village Health System to Predict Chronical Disease Empowered

With artificial neural network

In this proposed tovhs research, Iot based age, gender, bmi (body mass index), fever, nausea/vomiting, headache, diarrhea, fatigue, bone ache, jaundice, epigastria pain, wbc (white blood cells), rbc (red blood cells), hgb (hemoglobin), plat (platelet), ast1 (1 week), alt1 (1 week), alt4 (4 weeks), alt12 (12 weeks), alt24 (24 weeks), alt36 (36 weeks), alt48 (48 weeks), rna base, rna 4, rna12, rna eot and rna ef (elongation factor) parameters utilizing ANN (artificial neural network) approach have been developed for CHP (chronical health prediction). The ANN approach employs SCG, LM and BR algorithms for simulation.

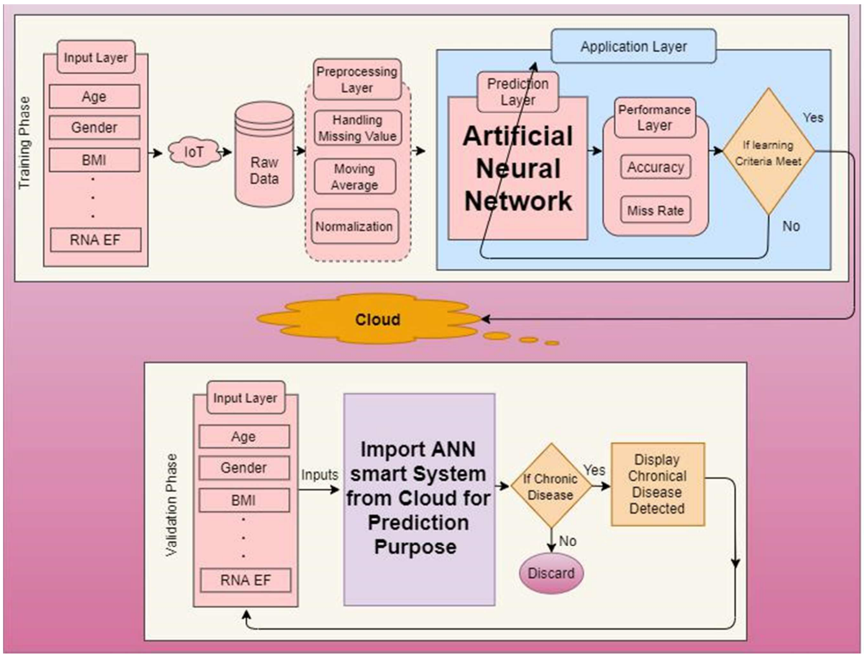

Figure 1. *Proposed IoT enabled Smart Village Health System to Predict Chronical Disease empowered with Artificial Neural Network.*

Figure 1 demonstrates the proposed toVHS approach which depends on two phases; Training and Validation. Both phases communicate through the cloud. The training phase further consists of the three layers namely; the sensory layer, preprocessing layer and application layer. The sensory layer.

contains various input parameters like Age, Gender, BMI (Body Mass Index), Fever, Nausea/Vomiting, Headache, Diarrhea, Fatigue, Bone ache, Jaundice, Epigastria pain, WBC (White Blood Cells), RBC (Red Blood Cells), HGB (Hemoglobin), Plat (Platelet), AST1 (1 week), ALT1 (1):

$$ɸ_u = b_1 + \sum_{g=1}^{a}(¥_{gu} * s_g) \quad (1)$$

€_i=1/ (1+e^ (-ɸ_u)) where u=1,2,3…c (2)

Input taken from the output layer is

$$ɸ_l = b_2 + \sum_{net=1}^{c}(Ꞷ_{ul} * €_u) \quad (3)$$

Output layer activation function is given below

€_l=1/(1+e^(-ɸ_l)) where l=1,2,3…s (4)

$$\mathbb{E} = \frac{1}{2}\sum_l(\Omega_l - €_l)^2 \quad (5)$$

The above equation represents backpropagation error where Ωl & O1 represent the desired output and estimated output. The layer is written according to the equation (6), rate of weight change for the output.

$$\Delta ¥ \propto -\frac{\partial \mathbb{E}}{\partial ¥}$$

$$\Delta W\_(u,l) = -\,\varepsilon\,\partial E/(\partial w\_(u,l)\ ) \quad (6)$$

After applying the Chain rule method above equation can be written as

$$\Delta W\_(u,l) = -\,\varepsilon\,\partial E/(\partial €\_l\ ) \times (\partial €\_l)/(\partial ɸ\_l\ ) \times (\partial ɸ\_l)/(\partial w\_(u,l)\ ) \quad (7)$$

The changed value of weight can be obtained after substituting the values in equation (7) as shown in equation (8)

$$\Delta Ꞷ_{u,l} = \varepsilon(\Omega_l - €_l) \times €_l(1 - €_l) \times (€_u)$$

$$\Delta W\_(u,l) = \varepsilon\Psi\_l\ €\_u \quad (8)$$

Where,

$$\Psi_l = (\Omega_l - €_l) \times €_l(1 - €_l)$$

Update weight between input and hidden layers by using the chain rule. After simplification above equation can be written as

$$\Delta ¥_{g,i} = \varepsilon\Psi_u\alpha_g$$

Where,

$$\Psi_u = \left[\sum_l \Psi_l\,(Ꞷ_{u,l})\right] \times €_u(1 - €_u)$$

$$W\_(u,l)^\wedge * = W\_(u,l) + \Lambda\_p\ \Delta W\_(u,l) \quad (9)$$

The equation above is used to update weights between output and hidden layers.

$$¥\_(g,u)^\wedge * = ¥\_(g,u) + \Lambda\_p\ \Delta ¥\_(g,u) \quad (10)$$

And the equation above is used to update the weight of the hidden & input layer.

After the prediction layer the output of the prediction layer will be sent to the performance layer to predict the CHP of villager basis on accuracy and miss rate whether the learning criteria meet or not. In case of 'NO' the prediction layer will be updated and so on but in case of 'Yes' the output will be stored on cloud database. Now, in the Validation phase, the input will be sensed from input layer parameters and sent to ANN for prediction that whether the CHP is found or not. In case of 'No' the process will be discarded and in case of 'Yes' the message will display that CHP found.

Table 1. *Training and validation of proposed iot enabled smart village health system to predict chronical disease empowered with artificial neural network.*

Proposed Algorithm		Training			Validation		
		5Neurons	10Neurons	15Neurons	5Neurons	10Neurons	15Neurons
LM	MSE	$6.91*10^{-1}$	$5.84*10^{-2}$	$5.68*10^{-2}$	$8.69*10^{-1}$	$7.98*10^{-1.5}$	$7.90*10^{-1.5}$
	Regression%	85.76	87.07	87.08	80.56	81.88	81.9
BR	MSE	$6.50*10^{-1}$	$4.82*10^{-2}$	$4.75*10^{-2.5}$	$8.01*10^{-1}$	$7.27*10^{-1.7}$	$7.12*10^{-1.7}$
	Regression%	86.21	89.88	92.92	81.31	84.61	84.63
SCG	MSE	$5.01*10^{-1.2}$	$3.42*10^{-2.5}$	$1.56*10^{-2.5}$	$7.26*10^{-1}$	$8.25*10^{-2.5}$	$8.07*10^{-2.5}$
	Regression%	87.54	94.54	95.69	83.39	90.39	90.39

In the case of hidden layer neurons are proposed ToVHS (smart health system) solution is varied with 5, 10, & 15 and observed that the system performance is also improved by increasing neurons. It also means that the performance of the system is improved by the number of neurons. The proposed SCG approach has produced promising results in comparison with LM and BR approaches with 15 hidden layer neurons. If in hidden layers the Number of neurons is 15, LM gives $7.90*10^{-1.5}$ MSE and 81.91 regression, BR gives $7.12*10^{-1.7}$ MSE and 84.63 regression and the SCG gives $8.07*10^{-2.5}$ MSE and 90.39 Regression in Validation, with this. It is observed that Scale Conjugate gives attractive results in terms of MSE and Regression when hidden layer neurons are 15 as compared to Levenberg Marquardt and Bayesian Regularization approaches. It was seen that the SCG algorithm has the highest accuracy rate with 90.39%.

4. Conclusion

We have transformed a village health system into a Smart Village Health System (SVHS) using the IoT and ANN. It is also designed for Chronical Health Prediction (CHP) of villagers to provide basic health facilities. In this paper a SVHS (smart village health system) model was proposed for CHP (chronical health prediction) based on HCV (Hypotyposis C virus) dataset. The SCG, LM and BR algorithms were implemented with ANN and IoT to develop SVHS and PCD (Prediction chronical disease). The evaluation of the proposed system showed that SCG algorithm gave promising results in terms of accuracy and Miss rate. The predicted accuracy of the proposed model showed 90.39% performance in CHP on the given factors.

References

[1] Jain, R. and Shah, H., 2016, October. An anomaly detection in smart cities modeled as wireless sensor network. In 2016 International Conference on Signal and Information Processing (IConSIP) (pp. 1-5). IEEE.

[2] Obinikpo, A. A. and Kantarci, B., 2017. Big sensed data meets deep learning for smarter health care in smart cities. Journal of Sensor and Actuator Networks, 6 (4), p. 26.

[3] Ranade, P., Londhe, S. and Mishra, A., 2015. Smart villages through information technology–need of emerging India. International Journal of Information Technology, 3 (7), pp. 1-6.

[4] Winkowska, J., Szpilko, D. and Pejić, S., 2019. Smart city concept in the light of the literature review. Engineering Management in Production and Services, 11 (2), pp. 70-86.

[5] Zavratnik, V., Kos, A. and Stojmenova Duh, E., 2018. Smart villages: Comprehensive review of initiatives and practices. Sustainability, 10 (7), p. 2559.

[6] Sˆırb, L., The alternative strategy selection for sustainable development using fuzzy logic. Acta Universitatis Apulensis.

[7] Provitolo, D., 2012. The Contribution of Science and Technology to Meeting the Challenge of Risk and Disaster Reduction in Developing Countries: From Concrete Examples to the Proposal of a Conceptual Model of “Resiliencery Vulnerability”. In Technologies and innovations for development (pp. 131-153). Springer, Paris.

[8] Broadbent, E., Tamagawa, R., Patience, A., Knock, B., Kerse, N., Day, K. and MacDonald, B. A., 2012. Attitudes towards health‐care robots in a retirement village. Australasian journal on ageing, 31 (2), pp. 115-120.

[9] Carroll, J. A., Adkins, B. A., Foth, M. and Parker, E. A., 2007. The Kelvin Grove Urban Village: what aspects of design are important for connecting people, place, and health? In Proceedings of the 2007 International Urban Design Conference.

[10] Damen, I., Brankaert, R., Xue, M., Chen, X., Grave, A. and Vos, S., 2019, May. ROOT: A Multidisciplinary Approach to Urban Health Challenges with HCI. In Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems (pp. 1-7).

[11] Hossain, M. S., Muhammad, G. and Alamri, A., 2019. Smart healthcare monitoring: A voice pathology detection paradigm for smart cities. Multimedia Systems, 25 (5), pp. 565-575.

[12] Coutinho, M. M., Vasconcellos Sobrinho, M., Oliveira, S. D. and Santiago, A. M., 2019. Coproduction between government and civil society to establish smart cities in the state of Pará. Revista de Administração Contemporânea, 23 (5), pp. 636-653.

[13] Demirkan, H., 2013. A smart healthcare systems framework. It Professional, 15 (5), pp. 38-45.

[14] Boulos, M. N. K., Peng, G. and VoPham, T., 2019. An overview of GeoAI applications in health and healthcare.

[15] Solanas, A., Patsakis, C., Conti, M., Vlachos, I. S., Ramos, V., Falcone, F., Postolache, O., Pérez-Martínez, P. A., Di Pietro, R., Perrea, D. N. and Martinez-Balleste, A., 2014. Smart health: a context-aware health paradigm within smart cities. IEEE Communications Magazine, 52 (8), pp. 74-81.

[16] Patsakis, C., Venanzio, R., Bellavista, P., Solanas, A. and Bouroche, M., 2014, June. Personalized medical services using smart cities' infrastructures. In 2014 IEEE International Symposium on Medical Measurements and Applications (MeMeA) (pp. 1-5). IEEE.

[17] Olshansky, S. J., Carnes, B. A., Yang, Y. C., Miller, N., Anderson, J., Beltrán-Sánchez, H. and Ricanek, K., 2016. The future of smart health. Computer, (11), pp. 14-21.

[18] Liu, S., Li, W. and Liu, K., 2014, May. Pragmatic oriented data interoperability for smart healthcare information systems. In 2014 14th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (pp. 811-818). IEEE.

[19] Samani, H. and Zhu, R., 2016. Robotic automated external defibrillator ambulance for emergency medical service in smart cities. IEEE Access, 4, pp. 268-283.

[20] Béguelin, C., Suter, A., Bernasconi, E., Fehr, J., Kovari, H., Bucher, H. C., Stoeckle, M., Cavassini, M., Rougemont, M., Schmid, P. and Wandeler, G., 2018. Trends in HCV treatment uptake, efficacy and impact on liver fibrosis in the Swiss HIV Cohort Study. Liver international, 38 (3), pp. 424-431.

[21] McNeil, C. and Wenn, D., 2010. Smart Integrated Biodiagnostic Systems for Healthcare. E-Health,

[22] Banerjee, A. and Gupta, S. K., 2014. Analysis of smart mobile applications for healthcare under dynamic context changes. IEEE Transactions on Mobile Computing, 14 (5), pp. 904-919.

[23] Laplante, N., Laplante, P. A., Voas, J. and Cleland-Huang, J., 2016. Caring: An Undiscovered" Super-ility" of Smart Healthcare. IEEE software, 33 (6), pp. 16-19.

[24] Vignesh, R. K. and Priyan, R. S., 2019. Development of village as a smart village–A case study on Ponkurichi village.

[25] Palanki, R., Qualcomm Inc, 2014. Frequency hopping design for single carrier FDMA systems. U.S. Patent 8, 917, 654.

[26] Dua, D. and Graff, C. (2019). UCI Machine Learning Repository [http://archive.ics.uci.edu/ml]. Irvine, CA: University of California, School of Information and Computer Science.

[27] Jahromi, M. N., Gomeh, Z., Busico, G., Barzegar, R., Samany, N. N., Aalami, M. T., ... & Kazakis, N. (2021). Developing a SINTACS-based method to map groundwater multi-pollutant vulnerability using evolutionary algorithms. Environmental Science and Pollution Research, 28 (7), 7854-7869.

[28] Sharma, M., Pradhyumna, S. P., Goyal, S., & Singh, K. (2021). Machine Learning and Evolutionary Algorithms for the Diagnosis and Detection of Alzheimer's Disease. In Data Analytics and Management (pp. 229-250). Springer, Singapore.

[29] Niu, W. J., Feng, Z. K., Yang, W. F., & Zhang, J. (2020). Short-term streamflow time series prediction model by machine learning tool based on data preprocessing technique and swarm intelligence algorithm. Hydrological Sciences Journal, 65 (15), 2590-2603.

[30] Ravindranath, V., Ramasamy, S., Somula, R., Sahoo, K. S., & Gandomi, A. H. (2020, July). Swarm intelligence-based feature selection for intrusion and detection system in cloud infrastructure. In 2020 IEEE Congress on Evolutionary Computation (CEC) (pp. 1-6). IEEE.

[31] Jain, A. C., Marchand, D., Glensk, A., Ceriotti, M., & Curtin, W. A. (2021). Machine learning for metallurgy III: A neural network potential for Al-Mg-Si. Physical Review Materials, 5 (5), 053805.

[32] Karatach, S. A., & Sinuk, V. G. E. (2021). Machine learning of a fuzzy system with linguistic inputs using parallel technologies. Информационные технологии и вычислительные системы, (3), 60-69.