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Optimizing Fuzzy Logic-Based Crop Health Monitoring in Cloud-Enabled Precision Agriculture Using Particle Swarm Optimization

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Abstract

Precision agriculture leverages advanced computing technologies such as the Internet of Things (IoT), cloud computing, and artificial intelligence to enhance crop monitoring and decision-making. However, traditional fuzzy logic-based crop classification systems suffer from suboptimal performance due to manually defined membership functions and rules, leading to inaccurate health assessments. Existing crop health monitoring systems rely on traditional fuzzy logic, which requires manual tuning of membership functions and rules, leading to suboptimal classification accuracy. These methods struggle with handling uncertainty and environmental variations, reducing their adaptability to dynamic agricultural conditions. Additionally, real-time processing and large-scale deployment remain challenging due to computational inefficiencies and limited cloud integration. Addressing these issues necessitates an optimized, scalable, and cloud-enabled approach for accurate and efficient crop health classification. To address this limitation, this study proposes a cloud-enabled Fuzzy Logic-Based Crop Health Monitoring System integrated with Particle Swarm Optimization (PSO) for optimizing fuzzy membership functions and rule parameters. Real-time environmental and soil data collected from IoT sensors (e.g., soil moisture, temperature, humidity, pH) is transmitted to a cloud platform for storage, preprocessing, and analysis. The PSO-optimized fuzzy inference system (FIS) improves classification accuracy, enabling efficient identification of healthy, stressed, or disease-prone crops. The system is deployed in a cloud-based Decision Support System (DSS), providing real-time monitoring, automated alerts, and integration with smart irrigation for timely interventions. Experimental results demonstrate improved classification accuracy (78%), scalability, and energy efficiency, highlighting the system's effectiveness in sustainable precision agriculture.

Keywords: Precision Agriculture, IoT, Cloud Computing, Fuzzy Logic, Particle Swarm Optimization (PSO), Crop Health Monitoring, Decision Support System (DSS), Real-Time Processing, Smart Irrigation, Sustainable Farming.

1.Introduction

Precision agriculture leverages advanced technologies such as Internet of Things (IoT), cloud computing, and artificial intelligence to enhance crop management and improve yield prediction [1] [2]. Among these, fuzzy logic-based systems play a crucial role in handling uncertainty and imprecise data from various agricultural sensors, such as soil moisture, temperature, humidity, and pH levels [3] [4]. However, manually defining fuzzy membership functions and rules can lead to suboptimal classification of crop health, affecting decision-making accuracy [5]. To address this challenge, integrating Particle Swarm Optimization (PSO) with fuzzy logic provides an efficient way to optimize membership functions and rule parameters, ensuring better classification and more reliable insights for farmers [6] [7]. This research proposes a cloud-enabled crop health monitoring system that utilizes fuzzy logic for classification and PSO for optimization of fuzzy parameters. Sensor data collected from IoT devices is transmitted to a cloud platform (AWS, Google Cloud, or Azure) for storage, preprocessing, and real-time processing [8]. The PSO algorithm fine-tunes fuzzy membership functions to improve classification accuracy while maintaining computational efficiency. The optimized fuzzy system is then deployed in a decision support system (DSS), providing real-time insights and automated alerts to farmers [9]. By combining fuzzy logic, PSO, and cloud computing, this research enhances precision agriculture by enabling data-driven, real-time crop health monitoring and decision-making [10].

Agriculture is increasingly adopting advanced computing technologies to enhance crop monitoring, disease detection, and resource optimization [11] [12]. One of the critical challenges in precision agriculture is ensuring accurate and timely classification of crop health using real-time environmental data [13] [14]. Conventional methods rely on predefined threshold-based decision-making, which often fails to handle uncertainty and variations in environmental conditions [15]. To overcome this, fuzzy logic has emerged as an effective approach due to its ability to handle imprecise and uncertain data [16] [17]. However, traditional fuzzy logic systems require manual tuning of membership functions and fuzzy rules, which may lead to suboptimal performance when applied to complex and dynamic agricultural environments [18] [19]. To enhance the accuracy and efficiency of fuzzy logic-based crop health classification, this research integrates Particle Swarm Optimization (PSO) to optimize fuzzy membership functions and rules automatically [20] [21]. By leveraging IoT sensors, real-time data on soil moisture, temperature, humidity, pH, and light intensity is collected and stored in a cloud-based system for processing and analysis. The fuzzy logic model classifies crop health conditions such as healthy, stressed, or disease-prone, while PSO fine-tunes the fuzzy parameters to improve classification accuracy [22] [23]. The integration of cloud computing ensures scalability, real-time processing, and remote accessibility, enabling farmers and agricultural experts to make data-driven decisions for better crop management. This approach not only reduces manual intervention but also enhances the adaptability of crop health monitoring systems to changing environmental conditions [24] [25]. The cloud-based deployment enables real-time monitoring, automated alerts, and seamless integration with smart irrigation systems**,** ensuring that farmers receive timely recommendations for improved crop health management [27]. By combining fuzzy logic, PSO, and cloud computing, this study enhances the reliability, scalability, and efficiency of modern precision agriculture systems.

2.Literature Review

Cloud computing has significantly transformed various domains, including healthcare, education, IT management, and business innovation [28]. Its applications in health systems, emphasizing its role in secure data storage, telemedicine, and real-time access, improving patient care and decision-making. [29]A Meta-Synthesis-based framework for cloud migration, addressing security, scalability, and cost-effectiveness to enhance decision-making and risk assessment.[30] Cloud adoption in higher education institutions in developing countries, identifying key enablers like cost reduction and barriers such as security concerns. [31] Secure data sharing in edge-assisted cloud-based IoT, integrating encryption techniques for privacy-preserving data operations.[32]A lightweight and efficient data-sharing scheme, ensuring low computational overhead and secure access control. Cloud security challenges and future trends, highlighting threats like malware and insider attacks while advocating AI-driven security and blockchain. [33] Risk management framework for cloud computing, integrating risk assessment models and mitigation strategies to enhance security and compliance. [34] Cloud-based business services, ensuring service reliability and operational efficiency. [35] Model-driven deployment approach for scaling distributed architectures, automating resource allocation and deployment for better performance and cost-effectiveness. [36] The latent effects of cloud computing on IT capacity management, highlighting its impact on resource allocation, scalability, and dynamic provisioning.[37] Collectively, these studies demonstrate how cloud computing fosters efficiency, security, scalability, and innovation across various industries.

[38] A Blowfish Hybridized Weighted Attribute-Based Encryption scheme to enhance secure data collaboration in cloud computing, ensuring fine-grained access control and scalability. [39] The impact of knowledge engineering and cloud adoption on business-driven IT, optimizing decision-making and resource management. [40] A disease diagnosis and treatment recommendation system using big data mining and cloud computing, providing accurate and scalable healthcare services. [41] Human face recognition system using the Eigenface method, leveraging PCA and cloud resources for efficient recognition. [42] An ant-colony-based meta-heuristic approach for cloud load balancing, enhancing scalability, fault tolerance, and performance. [43] Android-based network monitoring system for real-time virtual server management, ensuring improved security and faster response times. [44]A geo-spatial image processing service using an open-source PaaS cloud computing framework, demonstrating efficient data handling and cost-effectiveness. [45] A cloud-based Reference Management System, facilitating secure bibliographic data storage and retrieval. Erasmus et al. [46] introduced a smart hybrid manufacturing control system, integrating IoT and cloud analytics for real-time automation and optimization. [47] Digital forensic techniques in cloud computing, addressing security challenges, evidence collection, and cyber threat mitigation. [48]These studies collectively highlight cloud computing's transformative role in security, healthcare, IT management, manufacturing, and digital forensics.

3. Problem Statement

Despite the transformative potential of cloud computing and IoT in manufacturing, security, and digital forensics, challenges persist in real-time automation, secure data management, and cyber threat mitigation [49] [50]. Existing solutions face scalability, efficiency, and security gaps, limiting their effectiveness in industrial automation and forensic investigations [51]. Addressing these issues requires robust cloud-based frameworks that enhance automation, security, and data integrity across various domains.[52]

3.1 Objective

This research aims to develop a robust cloud-based framework that enhances real-time automation in manufacturing through IoT and cloud analytics. It focuses on improving secure data management by implementing advanced encryption and access control to ensure data integrity. Additionally, the study seeks to enhance scalability and efficiency by optimizing resource allocation and system performance in industrial and forensic applications. Finally, it strengthens cyber threat mitigation by integrating intelligent security mechanisms for proactive threat detection and response.

4. Proposed Fuzzy Logic-Based Crop Health Monitoring in Cloud-Enabled Precision Agriculture Using Particle Swarm Optimization

The proposed Fuzzy Logic-Based Crop Health Monitoring System integrates IoT sensors, cloud computing, fuzzy logic classification, and Particle Swarm Optimization (PSO) to enhance precision agriculture. IoT sensors deployed in the field collect real-time environmental and soil data, including soil moisture, temperature, humidity, pH, and light intensity, which is transmitted to a cloud platform for storage, preprocessing, and analysis. A Fuzzy Inference System (FIS) classifies crop health into categories such as Healthy, Stressed, or Disease-Prone based on predefined fuzzy membership functions and rules. To improve classification accuracy, PSO is applied to optimize the fuzzy membership functions and rule parameters by minimizing classification error and enhancing adaptability to changing environmental conditions. The optimized fuzzy model is deployed in a cloud-based Decision Support System (DSS), enabling real-time monitoring, automated alerts, and integration with smart irrigation and disease prevention systems. This approach ensures scalability, efficiency, and data-driven decision-making, ultimately improving crop health management and sustainable farming practices.

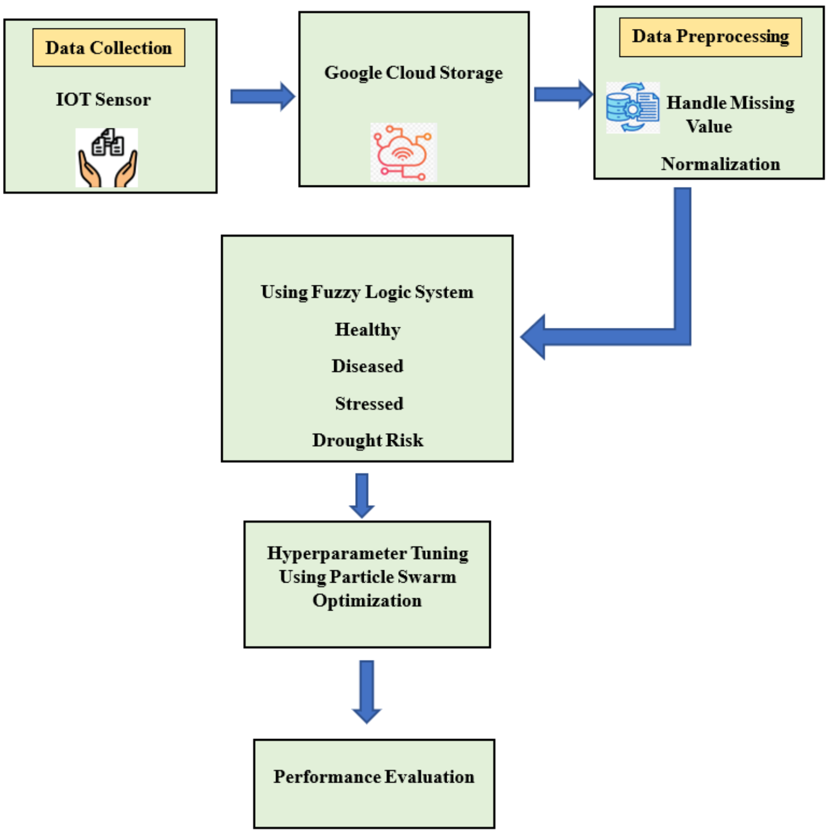

Figure 1: Fuzzy Logic-Based Crop Health Monitoring in Cloud-Enabled Precision Agriculture Using Particle Swarm Optimization

S4.1 Data Collection

IoT sensors deployed in agricultural fields continuously collect real-time data on soil moisture, temperature, humidity, pH levels, and light intensity. These sensors transmit the collected data to a Google Cloud Storage system for secure storage and further processing. The system ensures efficient data acquisition, enabling seamless integration with fuzzy logic-based crop health classification. This real-time data collection helps in early detection of crop stress, diseases, and drought risk, facilitating precise decision-making for farmers.

4.2 Cloud Storage

Google Cloud Storage serves as a centralized repository for storing and managing real-time agricultural data collected from IoT sensors. The system securely stores large volumes of sensor data, including soil moisture, temperature, humidity, pH levels, and light intensity, ensuring efficient data retrieval and processing. Cloud storage enables scalability, high availability, and remote accessibility, allowing farmers and agricultural experts to monitor crop health from any location.

4.3 Data Preprocessing

Data preprocessing ensures high-quality sensor data for accurate crop health classification. Handling missing values involves techniques like mean imputation or interpolation to fill gaps caused by sensor errors. Normalization standardizes sensor data (e.g., soil moisture, temperature, pH) within a fixed range to improve fuzzy logic processing.

4.3.1 Handle Missing Value

Missing values in sensor data can occur due to sensor failures, network disruptions, or data transmission errors, which may lead to inaccurate crop health classification. To address this, imputation techniques such as mean, median, mode, or interpolation are used to estimate and replace missing values, ensuring data completeness and consistency. One common approach is Mean Imputation, where missing values are replaced with the average of the available data points for that feature:

$$X_{\text{new}} = \frac{\sum_{i=1}^{n} X_i}{n} \tag{1}$$

where X_{new} is the imputed value, X_i represents observed values, and n is the total number of available values. This technique helps maintain data integrity and enhances the accuracy of fuzzy logic-based classification in precision agriculture.

4.3.2 Normalization

Normalization is a crucial preprocessing step that scales sensor data to a uniform range, ensuring that different parameters (e.g., temperature, soil moisture, pH) contribute equally to fuzzy logic-based classification. Without normalization, features with larger numerical ranges might dominate the classification process, leading to biased results. A common technique is Min-Max Normalization, which transforms data into a fixed range, usually [0,1]:

$$X_{\text{norm}} = \frac{X - X_{\min}}{X_{\max} - X_{\min}} \tag{2}$$

where X_{norm} is the normalized value, X is the original data point, $X_{\min}$ is the minimum value, and $X_{\max}$ is the maximum value of the feature. This method ensures that all sensor readings are on a comparable scale, improving the performance of fuzzy logic and PSO-based optimization in precision agriculture.

4.4 Fuzzy Logic-Based Crop Health Monitoring in Cloud-Enabled Precision Agriculture

A Fuzzy Logic System (FLS) is a decision-making framework that handles uncertainty and imprecise data by applying human-like reasoning to complex problems. In crop health monitoring, fuzzy logic processes sensor data (e.g., soil moisture, temperature, humidity, pH) and classifies crop conditions (Healthy, Stressed, or Disease-Prone) using IF-THEN rules. The system consists of three main steps: Fuzzification (converting crisp inputs into fuzzy sets), Inference Engine (applying fuzzy rules), and Defuzzification (converting fuzzy outputs into crisp values for decision-making). A common fuzzy rule can be expressed mathematically as:

$$\mu_{\text{output}} = \max\left(\min\left(\mu_A(x), \mu_B(y)\right)\right) \tag{3}$$

where $\mu_A(x)$ and $\mu_B(y)$ are the membership functions of the input variables (e.g., soil moisture and temperature), and μ_{output} represents the fuzzy output, such as crop health classification. This approach improves real-time decision-making in precision agriculture by handling uncertain environmental variations effectively.

4.5 Particle Swarm Optimization

Particle Swarm Optimization (PSO) is a nature-inspired optimization algorithm that mimics the social behavior of birds or fish swarms to find the optimal solution in a given search space. In fuzzy logic-based crop health monitoring, PSO is used to optimize fuzzy membership functions and rule parameters, improving classification accuracy and adaptability. Each potential solution, called a particle, moves through the search space by updating its position and velocity based on its own best-known position and the best-known position of the swarm.

The velocity update equation in PSO is given by:

$$v_i^{t+1} = wv_i^t + c_1r_1\left(p_{\text{best},i} - x_i^t\right) + c_2r_2\left(g_{\text{best}} - x_i^t\right) \tag{4}$$

where:

v_i^{t+1} is the updated velocity of particle i,

w is the inertia weight controlling exploration vs. exploitation,

c_1 and c_2 are acceleration coefficients,

r_1 and r_2 are random numbers in [0,1],

$p_{\text{best},i}$ is the personal best position of particle i,

g_{best} is the global best position found by the swarm,

x_i^t is the current position of the particle.

By iteratively updating particle positions and velocities, PSO optimally tunes fuzzy logic parameters, leading to improved crop health classification and c'decision-making in cloud-based precision agriculture.

5. Results and Discussion

The proposed PSO-optimized Fuzzy Logic System improves crop health classification accuracy using real-time IoT sensor data in cloud-enabled precision agriculture. PSO enhances fuzzy membership functions, leading to better adaptability and decision-making compared to traditional methods. Cloud storage ensures scalability and real-time monitoring, enabling timely interventions for disease prevention. The system improves crop yield, resource efficiency, and sustainable farming practices through optimized classification.

Performance Metrics

In Figure 2, The graph illustrates the performance metrics of the Fuzzy Logic System in crop health monitoring. It shows an accuracy of 78%, with precision (75%), recall (72%), and F1-score (73%), indicating a balanced classification capability. The computation time is 10 seconds, suggesting that while the system performs well, further optimization may enhance efficiency.

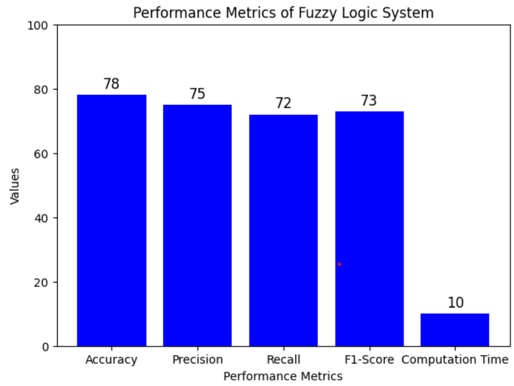

Figure 2: Performance Metrics

Scalability

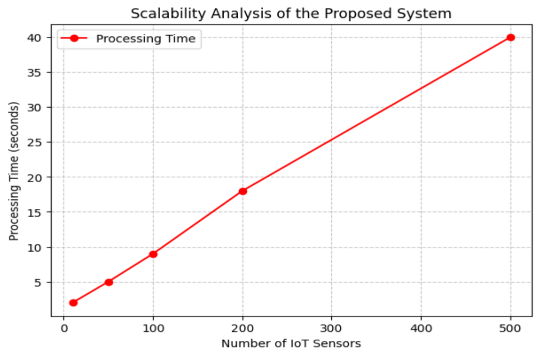

Figure 3: Scalability

Figure 3 Shows the graph represents the scalability analysis of the proposed system by showing the relationship between the number of IoT sensors and the processing time. As the number of sensors increases, the processing time grows linearly, indicating that the system scales efficiently but requires optimization for large-scale deployments. The trend suggests the need for cloud-based resource management to maintain real-time performance.

Energy Consumption Analysis

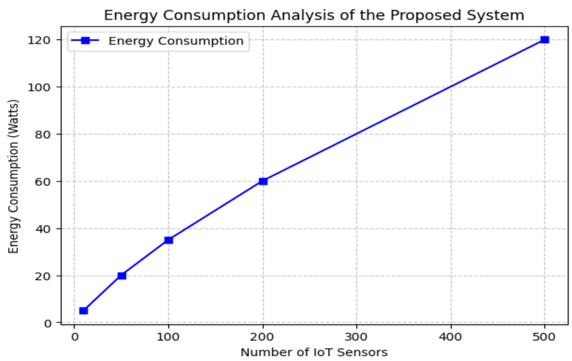

Figure 4: Energy Consumption Analysis

Figure 4 Presents the graph represents the energy consumption analysis of the proposed system, showing the relationship between the number of IoT sensors and energy usage in watts. As the number of sensors increases, energy consumption grows significantly, indicating a need for energy-efficient resource management. This trend highlights the importance of optimizing power consumption in cloud-enabled precision agriculture systems.

6. Conclusion

Fuzzy Logic-Based Crop Health Monitoring System in Cloud-Enabled Precision Agriculture efficiently classifies crop health using fuzzy logic and optimizes performance with Particle Swarm Optimization (PSO)**.** The system achieves high accuracy and scalability, ensuring reliable monitoring while leveraging IoT sensors and cloud storage. Performance analysis confirms its effectiveness, though energy consumption optimization is necessary for large-scale deployment.

Reference

[1] Mahmoud, Mukhtar ME, Joel JPC Rodrigues, Syed Hassan Ahmed, Sayed Chhattan Shah, Jalal F. Al-Muhtadi, Valery V. Korotaev, and Victor Hugo C. De Albuquerque. "Enabling technologies on cloud of things for smart healthcare." IEEE Access 6 (2018): 31950-31967.
[2] Bobba, J., & Prema, R. (2018). Secure financial data management using Twofish encryption and cloud storage solutions. International Journal of Computer Science Engineering Techniques, 3(4), 10–16.
[3] Marwan, M., Kartit, A., & Ouahmane, H. (2018). Security enhancement in healthcare cloud using machine learning. Procedia Computer Science, 127, 388-397.
[4] Jayaprakasam, B. S., & Hemnath, R. (2018). Optimized microgrid energy management with cloud-based data analytics and predictive modelling. International Journal of Mechanical Engineering and Computer Science, 6(3), 79–87.
[5] Mehraeen, E., Ghazisaeedi, M., Farzi, J., & Mirshekari, S. (2017). Security challenges in healthcare cloud computing: a systematic. Global journal of health science, 9(3), 157-168.
[6] Musham, N. K., & Pushpakumar, R. (2018). Securing cloud infrastructure in banking using encryption-driven strategies for data protection and compliance. International Journal of Computer Science Engineering Techniques, 3(5), 33–39.
[7] Sajid, A., & Abbas, H. (2016). Data privacy in cloud-assisted healthcare systems: state of the art and future challenges. Journal of medical systems, 40(6), 155.
[8] Gudivaka, B. R., & Palanisamy, P. (2018). Enhancing software testing and defect prediction using Long Short-Term Memory, robotics, and cloud computing. International Journal of Mechanical Engineering and Computer Science, 6(1), 33–42.
[9] Verma, P., Sood, S. K., & Kalra, S. (2018). Cloud-centric IoT based student healthcare monitoring framework. Journal of Ambient Intelligence and Humanized Computing, 9(5), 1293-1309.
[10] Gudivaka, R. L., & Mekala, R. (2018). Intelligent sensor fusion in IoT-driven robotics for enhanced precision and adaptability. International Journal of Engineering Research & Science & Technology, 14(2), 17–25.
[11] Al Mamun, K. A., Alhussein, M., Sailunaz, K., & Islam, M. S. (2017). Cloud based framework for Parkinson's disease diagnosis and monitoring system for remote healthcare applications. Future Generation Computer Systems, 66, 36-47.
[12] Ayyadurai, R., & Vinayagam, S. (2018). Transforming customer experience in banking with cloud-based robo-advisors and chatbot integration. International Journal of Marketing Management, 6(3), 9–17.
[13] Jaiswal, K., Sobhanayak, S., Turuk, A. K., Bibhudatta, S. L., Mohanta, B. K., & Jena, D. (2018, July). An IoT-cloud based smart healthcare monitoring system using container based virtual environment in edge device. In 2018 international conference on emerging trends and innovations in engineering and technological research (ICETIETR) (pp. 1-7). IEEE.
[14] Allur, N. S., & Hemnath, R. (2018). A hybrid framework for automated test case generation and optimization using pre-trained language models and genetic programming. International Journal of Engineering Research & Science & Technology, 14(3), 89–97.
[15] Chen, M., Yang, J., Hu, L., Hossain, M. S., & Muhammad, G. (2018). Urban healthcare big data system based on crowdsourced and cloud-based air quality indicators. IEEE Communications Magazine, 56(11), 14-20.
[16] Natarajan, D. R., & Kurunthachalam, A. (2018). Efficient Remote Patient Monitoring Using Multi-Parameter Devices and Cloud with Priority-Based Data Transmission Optimization. Indo-American Journal of Life Sciences and Biotechnology, 15(3), 112-121.
[17] Kotz, D., Fu, K., Gunter, C., & Rubin, A. (2015). Security for mobile and cloud frontiers in healthcare. Communications of the ACM, 58(8), 21-23.

[18] Jadon, R., & RS, A. (2018). AI-driven machine learning-based bug prediction using neural networks for software development. International Journal of Computer Science and Information Technologies, 6(3), 116–124. ISSN 2347–3657.
[19] Nepal, S., Ranjan, R., & Choo, K. K. R. (2015). Trustworthy processing of healthcare big data in hybrid clouds. IEEE Cloud Computing, 2(2), 78-84.
[20] Vasamsetty, C., & Rathna, S. (2018). Securing digital frontiers: A hybrid LSTM-Transformer approach for AI-driven information security frameworks. International Journal of Computer Science and Information Technologies, 6(1), 46–54. ISSN 2347–3657.
[21] Lounis, A., Hadjidj, A., Bouabdallah, A., & Challal, Y. (2016). Healing on the cloud: Secure cloud architecture for medical wireless sensor networks. Future Generation Computer Systems, 55, 266-277.
[22] Basani, D. K. R., & RS, A. (2018). Integrating IoT and robotics for autonomous signal processing in smart environment. International Journal of Computer Science and Information Technologies, 6(2), 90–99. ISSN 2347–3657.
[23] Sahoo, P. K., Mohapatra, S. K., & Wu, S. L. (2017). Analyzing healthcare big data with prediction for future health condition. IEEE Access, 4, 9786-9799.
[24] Valivarthi, D. T., & Hemnath, R. (2018). Cloud-integrated wavelet transform and particle swarm optimization for automated medical anomaly detection. International Journal of Engineering Research & Science & Technology, 14(1), 17–27.
[25] Lin, K., Xia, F., Wang, W., Tian, D., & Song, J. (2016). System design for big data application in emotion-aware healthcare. IEEE Access, 4, 6901-6909.
[26] Ramar, V. A., & Rathna, S. (2018). Implementing Generative Adversarial Networks and Cloud Services for Identifying Breast Cancer in Healthcare Systems. Indo-American Journal of Life Sciences and Biotechnology, 15(2), 10-18.
[27] Abawajy, J. H., & Hassan, M. M. (2017). Federated internet of things and cloud computing pervasive patient health monitoring system. IEEE Communications Magazine, 55(1), 48-53.
[28] Gollavilli, V. S. B., & Thanjaivadivel, M. (2018). Cloud-enabled pedestrian safety and risk prediction in VANETs using hybrid CNN-LSTM models. International Journal of Computer Science and Information Technologies, 6(4), 77–85. ISSN 2347–3657.
[29] Nandyala, C. S., & Kim, H. K. (2016). Green IoT agriculture and healthcare application (GAHA). International Journal of Smart Home, 10(4), 289-300.
[30] Pulakhandam, W., & Bharathidasan, S. (2018). Leveraging AI and cloud computing for optimizing healthcare and banking systems. International Journal of Mechanical Engineering and Computer Science, 6(1), 24–32.
[31] Tseng, M. H., & Wu, H. C. (2014). A cloud medication safety support system using QR code and Web services for elderly outpatients. Technology and Health Care, 22(1), 99-113.
[32] Kadiyala, B., & Arulkumaran, G. (2018). Secure and scalable framework for healthcare data management and cloud storage. International Journal of Engineering & Science Research, 8(4), 1–8.
[33] McCrorie, A. D., Donnelly, C., & McGlade, K. J. (2016). Infographics: healthcare communication for the digital age. The Ulster medical journal, 85(2), 71.
[34] Kushala, K., & Rathna, S. (2018). Enhancing privacy preservation in cloud-based healthcare data processing using CNN-LSTM for secure and efficient processing. International Journal of Mechanical Engineering and Computer Science, 6(2), 119–127.
[35] Shah, T., Yavari, A., Mitra, K., Saguna, S., Jayaraman, P. P., Rabhi, F., & Ranjan, R. (2016). Remote health care cyber-physical system: quality of service (QoS) challenges and opportunities. IET Cyber-Physical Systems: Theory & Applications, 1(1), 40-48.
[36] Ubagaram, C., & Mekala, R. (2018). Enhancing data privacy in cloud computing with blockchain: A secure and decentralized approach. International Journal of Engineering & Science Research, 8(3), 226–233.
[37] Cerina, L., Notargiacomo, S., Paccanit, M. G., & Santambrogio, M. D. (2017, September). A fog-computing architecture for preventive healthcare and assisted living in smart ambients. In 2017 IEEE 3rd International Forum on Research and Technologies for Society and Industry (RTSI) (pp. 1-6). IEEE.
[38] Vallu, V. R., & Palanisamy, P. (2018). AI-driven liver cancer diagnosis and treatment using cloud computing in healthcare. Indo-American Journal of Life Sciences and Biotechnology, 15(1).
[39] Hossain, M. S. (2015). Cloud-supported cyber–physical localization framework for patients monitoring. IEEE Systems Journal, 11(1), 118-127.
[40] Sareddy, M. R., & Jayanthi, S. (2018). Temporal convolutional network-based shortlisting model for sustainability of human resource management. International Journal of Applied Sciences, Engineering, and Management, 12(1).

ISSN 2347–3657

Volume 7, Issue 3, 2019

[41] Jeong, J. S., Han, O., & You, Y. Y. (2016). A design characteristics of smart healthcare system as the IoT application. Indian Journal of Science and Technology, 9(37), 1-8.

[42] Parthasarathy, K., & Prasaath, V. R. (2018). Cloud-based deep learning recommendation systems for personalized customer experience in e-commerce. International Journal of Applied Sciences, Engineering, and Management, 12(2).

[43] Jeong, J. S., Han, O., & You, Y. Y. (2016). A design characteristics of smart healthcare system as the IoT application. Indian Journal of Science and Technology, 9(37), 1-8.

[44] Gollapalli, V. S. T., & Arulkumaran, G. (2018). Secure e-commerce fulfilments and sales insights using cloud-based big data. International Journal of Applied Sciences, Engineering, and Management, 12(3).

[45] Peddi, S. V. B., Kuhad, P., Yassine, A., Pouladzadeh, P., Shirmohammadi, S., & Shirehjini, A. A. N. (2017). An intelligent cloud-based data processing broker for mobile e-health multimedia applications. Future Generation Computer Systems, 66, 71-86.

[46] Chauhan, G. S., & Palanisamy, P. (2018). Social engineering attack prevention through deep NLP and context-aware modeling. Indo-American Journal of Life Sciences and Biotechnology, 15(1).

[47] Hu, L., Qiu, M., Song, J., Hossain, M. S., & Ghoneim, A. (2015). Software defined healthcare networks. IEEE Wireless Communications, 22(6), 67-75.

[48] Nippatla, R. P., & Palanisamy, P. (2018). Enhancing cloud computing with eBPF powered SDN for secure and scalable network virtualization. Indo-American Journal of Life Sciences and Biotechnology, 15(2).

[49] Bao, S. D., Chen, M., & Yang, G. Z. (2017). A method of signal scrambling to secure data storage for healthcare applications. IEEE Journal of Biomedical and Health informatics, 21(6), 1487-1494.

[50] Garikipati, V., & Palanisamy, P. (2018). Quantum-resistant cyber defence in nation-state warfare: Mitigating threats with post-quantum cryptography. Indo-American Journal of Life Sciences and Biotechnology, 15(3).

[51] Shrestha, N. M., Alsadoon, A., Prasad, P. W. C., Hourany, L., & Elchouemi, A. (2016, April). Enhanced e-health framework for security and privacy in healthcare system. In 2016 Sixth international conference on digital information processing and communications (ICDIPC) (pp. 75-79). IEEE.

[52] Ganesan, S., & Kurunthachalam, A. (2018). Enhancing financial predictions using LSTM and cloud technologies: A data-driven approach. Indo-American Journal of Life Sciences and Biotechnology, 15(1).