JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

BLOCKCHAIN AND SMART CONTRACT FOR ACCESS CONTROL IN HEALTHCARE

Dr.V.Sujatha[1*],Kanchukommula V N D S Vasuki Gourav[2], Basam Bhargavi[3], Tadimalla Sailaja[4], AdapaAkshitha[5]
Professor: Vignan's Nirula Institute of Technology and Science for Women.
[1*]Assistant Professor:Vignan's Nirula Institute of Technology and Science for Women
[2,3,4,5] B.Tech Scholar: Vignan's Nirula Institute of Technology and Science for Women.
sujiekkurthi@gmail.com,22nn1a0586vasuki@gmail.com,basambhargavi4@gmail.com,tadimallasailu@gmail.com, 22nn1a0561.akshi@gmail.com

Abstract:

Blockchain technology is increasingly being recognized as a secure and reliable platform for data sharing in various industries such as finance, supply chain management, food industry, energy, internet of things, and healthcare. In this paper, we review existing literature and applications of blockchain technology in the healthcare sector. Additionally, we propose several blockchain-based workflows for improved data management within the healthcare eco system. These workflows include complex medical procedures such as surgery and clinical trials, as well as managing and accessing large amounts of medical data. We have also conducted a feasibility study to estimate the cost of implementing the medical smart contract system for healthcare management .This work aims to facilitate collaboration among stakeholders within the healthcare system to improve services and optimize costs.

Keywords:Blockchain,SmartContracts,AccessControl,HealthDataSecurity,Decentralization,PatientPrivacy, clinical trails, cost Analysis, Data Integrity, HealthCare Management ,Digital Transformation.

1. Introduction:

Blockchain technology has recently emerged as a key player in the digital revolution of the healthcare sector, according to several research studies [1-8]. This technology has the potential to transform the way traditional medical systems and businesses have been operating in the healthcare sector for decades[9-15]. Key Enabling Technologies such as Information and Communication Technologies (ICTs) and blockchain are driving the decentralization and digitalization of ,providing a modern and digitized healthcare ecosystem for both patients and service providers[16-19]. Blockchain applications for healthcare data management offer utilities for patients, doctors, and healthcare institutions in areas such as patient record access and control, claims and payments management, medical IoT security management, research data verification and exchange for financial auditing and transparency[20-28].In these applications, real-time updates to an encrypted, decentralized blockchain ledger are used to understand, monitor, and control medical information[29-33]. This also allows healthcare institutions to restrict un authorized access to sensitive information[34-38].

Health care management encompasses various processes, such as managing finances, personnel, patients, legal issues, logistics, and inventory, among others[39]. Medical work flows often involve repetitive tasks related to actual patient treatment that can be plotted as a series of conditional steps[40]. These steps are designed to enhance internal controls, improve efficiency, compliance, productivity, and reduce risk, work cycles, and overhead within hospitals and other healthcare service providers[41]. In this paper, multiple medical workflows are designed for different healthcare management application domains[42]. This work presents a healthcare smart contract system for medical data management and streamlining complex medical procedures[43]. We discuss the state-of-the-art blockchain research in the healthcare field implementation.

Ethereum-based solution for healthcare management. The purpose of this paper is also to indicate the potential use of blockchain in healthcare and to reveal blockchain research's challenges and possible directions. This systematic review includes only research that introduces an healthcare solution, algorithm, method, methodology, or architecture. Review type research, discussions of potential blockchain uses and applications, and other non-relevant publications are excluded. Using realistic clinical databases, the paper then studies the blockchain applicability to these healthcare workflows and the feasibility of current adoption of blockchain in different use cases[45-49].

2.Literature Survey:

Emerging block chain-based health care innovations ,including data sources, block chain technology, healthcare applications, and stakeholders, are conceptually divided into several layers. Gordon and Catalini [1] published a review on healthcare blockchain where they concluded their discussion on how block chain technology can enable patient-centric control of healthcare data sharing over institution centric control. In their study they examined how blockchain technology transforms the healthcare sector by enabling digital access rights, patient identification across the network, handling a large volume of healthcare data and data immutability. Daisuke et al. [2] worked on medical records using the Hyperledger fabric blockchain platform where they were sending medical data to the hyper ledger blockchain network. They have collected those medical records using smartphones. In their work, they were trying to make sure that healthcare data is registered to the Blockchain. Anuraag etal. [3]studied blockchain as a way to manage healthcare information e silently. In their study, they included various types of studies and most of the work among this study was discussing potential benefits and limitations of blockchain technology for healthcare without being provided any proof or system evaluation. They have concluded their discussion on how blockchain could be a better fit for managing health care records on the cloud system while maintaining security and privacy of data. Rouhani et al. [4] came up with an approach to address limitations of permission and permissionless blockchain. They have used an instance of Hyperledger platform for patient-controlled healthcare data management. Wu and Tsai [5]did a literature review on healthcare management systems and proposed two algorithms for providing network security. They also suggested using a distributed system for healthcare data management and establishing regulations for the healthcare data. Shen etal. [6] proposes a mechanism for sharing medical data using blockchain and peer to peer networks known as MedChain. They have designed this system for healthcare data generated via medical examination and the patient data collected from IoT sensors and other mobile apps. Khizretal.[7]discussed various issues of the healthcare management system and how it could be resolved using blockchain technology. They have presented the current research on healthcare using distributed ledger technology with some possible medical use cases where blockchain technology can play a significant role to make the process e client. They have also proposed the IoMT delivery system using networking protocols. Litchfield etal. [8] have discuss the disuses regarding healthcare data security and privacy and suggested blockchain to overcome the issues besides doing a survey on healthcare issues. Vora etal.[9]discussed breaching of patient information such as name, address etc. on a regular basis. They proposed blockchain mechanism to handle electronic health records.

The main goal of their paper was to analyse their system performance to see how their proposed framework handles the needs of a patient, doctors and third parties. Zhang et al. [10] wrote a book chapter proposal where they have discussed di event use cases of healthcare blockchain. They have highlighted the importance of the blockchain-based system for healthcare and how blockchain technology provides active healthcare design, Siyal etal.

2. Proposal Methodology:

Blockchain Based Smart Contracts for Healthcare

We use smart contracts from Ethereum to create smart representations of existing medical records that are stored on the network within individual nodes. We build contracts to contain record ownership metadata, permissions, and data integrity. Our system’s blockchain transactions carry crypto graphically signed instructions for managing these properties. State-transition functions of the contract carry out policies, only by legitimate transactions forcing data alternation. These regulations can be structured to enforce any set of

rules regulating a specific medical record as long as it can become potetiolly represented .For example, a policy may impose sending separate consent transactions from both We use smart contracts from Ethereum to create smart representations of existing medical records that are stored on the network within individual nodes. We build contracts to contain record ownership metadata, permissions, and data integrity. Our system's blockchain transactions carry cryptographically signed instructions for managing these properties. State-transition functions of the contract carryout policies, only by legitimate transaction forcing data alternation. These regulations can be structured to enforce any set of rules regulating a specific medical record as long as itcan be computationally represented. For example, a policy may impose sending separate consent transactions from both patients and healthcare professionals before granting a thirdparty viewing permission. We designed a system based on blockchain smart contracts for complex healthcare workflows.

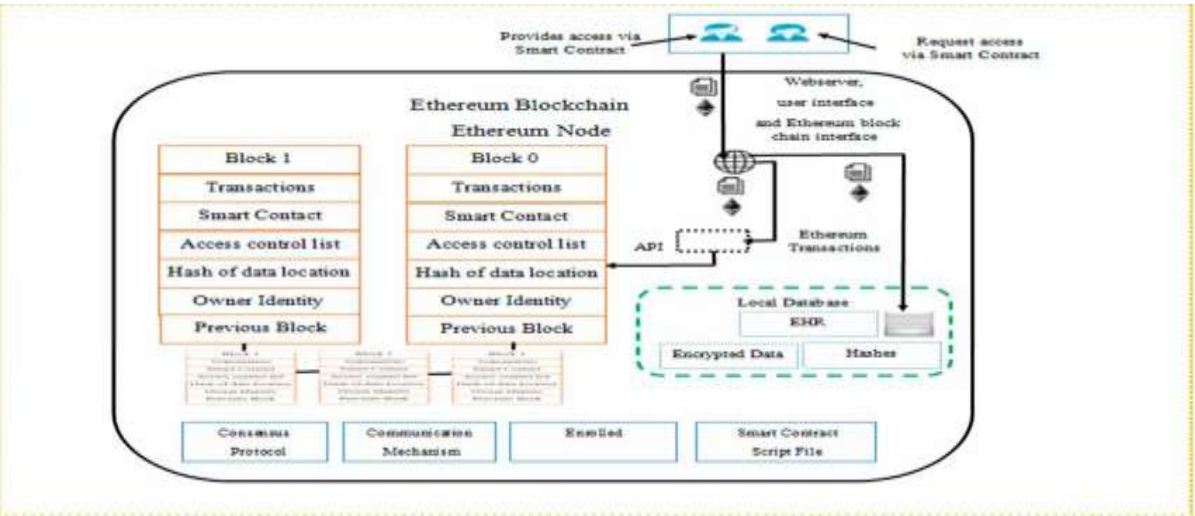

Figure1.System workflow with smart contractcontrolled access.

Outpatient Surgical Procedure Basic

Our workflow consists of various activities that are involved throughout the surgical patient process. This includes pre-approvals, medical clearance, surgery scheduling, pre-operative testing and recording consent. Throughout the process, the visit is recorded, treatment is reported and paid. This would be useful to review past surgical cases or surgeries that have been cancelled. Algorithmic workflow and the solidity smart contract components can be seen in Figure2 and Figure3 respectively.

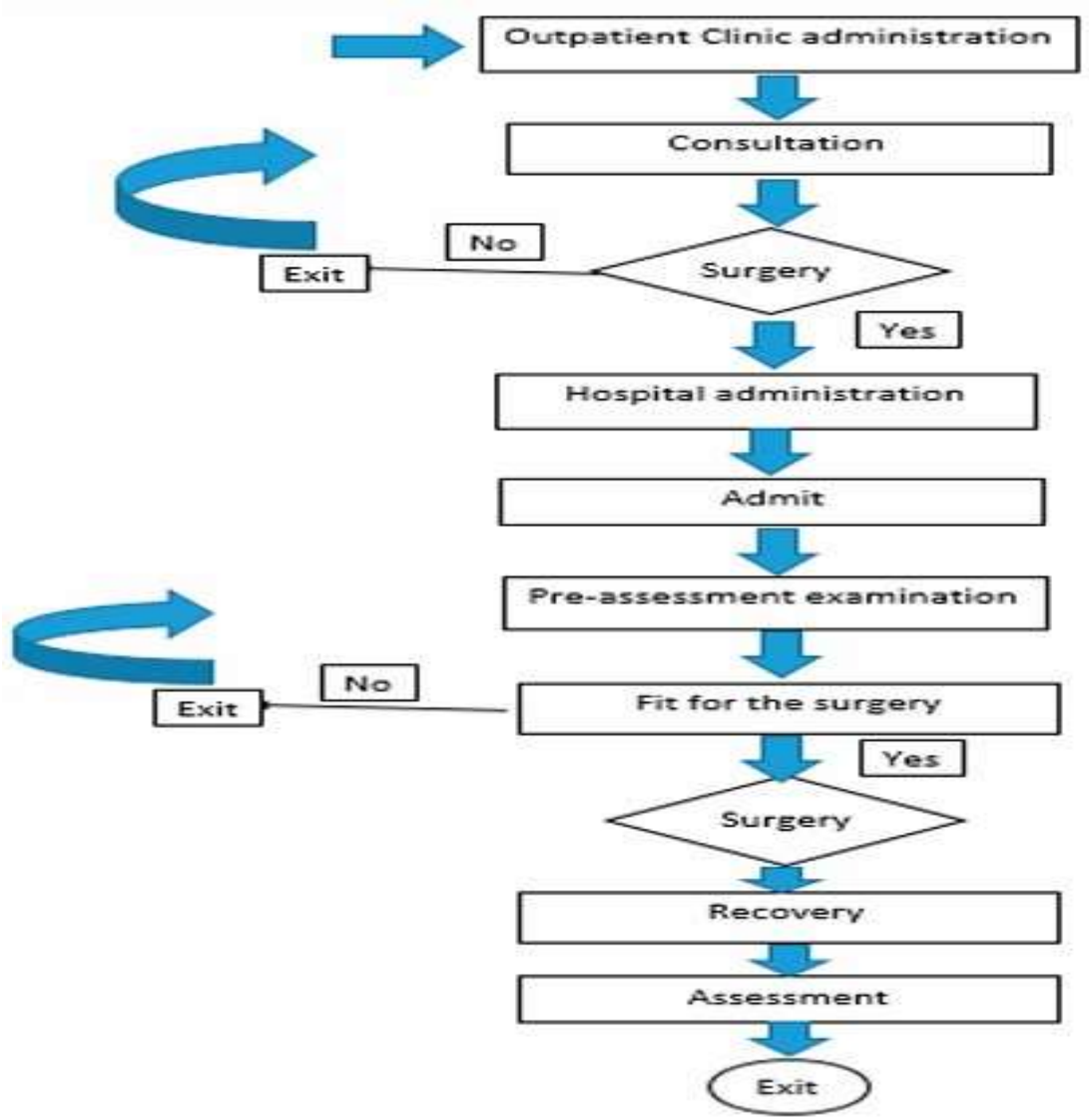

Figure2. Algorithmic workflow for a smart contract with surgery patients.

Algortihm:

Input: Access request: AR
Output: policy result

Get Doctor's **Identity Information** from Blockchain;
if identity information is legal **then**
for each Risk H(di) in **Access History do**
Risk H(di) = $\Sigma \sum_{j=1}^{k} E(tj)$ **Risk j(di);**
end
Risk(di) = {0, (H^{wt}(di) - H_{μ}^{wt} (di))};
Total Risk(di) = Risk H(di) + Risk(di);
for each R^{μ}(d) in **Malicious Doctor's Access History do**
φ **(t+1) = [**$(\mu + \sigma), (\mu + \sigma)$**];**
end
if Total Risk(di) <= $\varphi(t+1)$ *then*
policy result = allow;
end
else
policy result = deny;
end
else
policy result = deny;
end

return policy result**;**

3. RESULT:

It is widely known that patient information is stored in various formats across traditional healthcare delivery models, including providers, laboratories, payers(i.e., insurance companies),and drug companies. Furthermore, there is no standardized record-keeping system in place, leading to data breaches and the current disarray in health record exchange. The inadequate infrastructure for data sharing has also hindered progress in drug discovery and public health research. Efforts to resolve this issue have primarily focused on implementing a shared standard throughout the ecosystem, but these attempts have been unsuccessful due to factors such as regulation, lobbying, and patient apathy. As a result, the wide spread adoption of personalized medical treatment, which takes into account a patient's attributes, desires, and expectations, has been prevented. The healthcare industry has invested substantial resources in developing personalized healthcare options, but the current system has impeded progress in this area.

Figure4 .Smart contract deployment cost for Inpatients and Day cases (surgery) across direct departments/specialty

Figure5.Cost comparison among different smart contracts and entities.

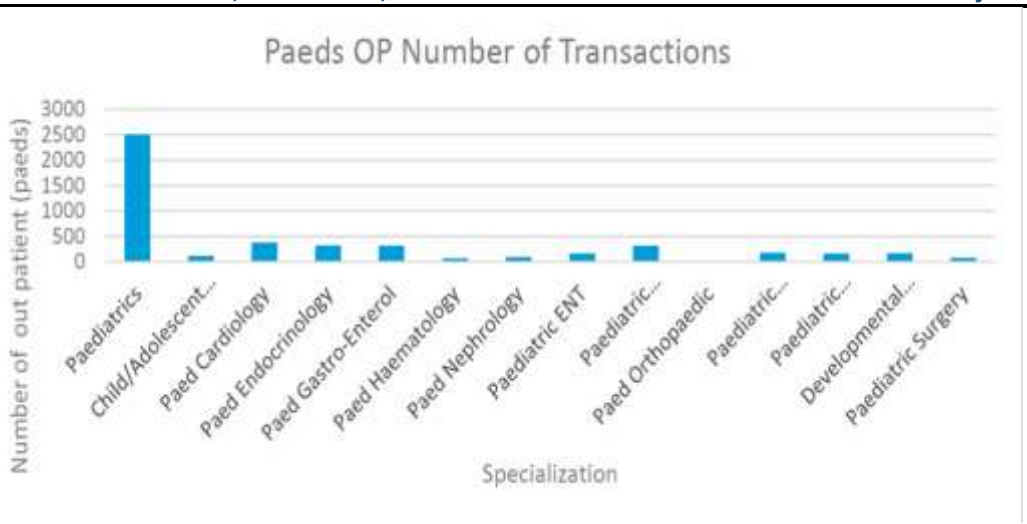

Figure 6. Cost comparison among different smart contracts and entities.

4. CONCLUSION:

The primary goal of incorporating block chain technology, as described in this paper, is to improve healthcare processes and ultimately lead to better patient outcomes. Blockchain offers several advantages, including reducing transaction costs by using smart contracts with
embedded with general-purpose protocols to streamline procedures, minimize administrative burdens, and eliminate intermediaries. Other blockchain initiatives focus on enhancing the collection, use, and sharing of health data from patients, researchers, and data sub-processors. Our proposed system employs blockchain technology to create an iterative, scalable, secure, accessible, and decentralized healthcare ecosystem. This would enable patients to freely and securely exchange their medical records with physicians, hospitals, research institutions, and other stakeholders while maintaining complete control over the privacy of their medical data. This solution would address several current issues in the healthcare system, such as data siloing, legacy network incompatibility ,unstructured data collection difficulties, prohibitively high administrative costs, insufficient data security, and un addressed privacy concerns.

5. REFERENCES:

1. Gordon,W.J.;Catalini,C.Blockchaintechnologyforhealthcare:Facilitatingthetransition to patient-driven interoperability. Compute. Struct. Biotechnology. J. 2018,16,224–230.[CrossRef]

2. Daisuke, I.; Kashiyama, M.; Ueno, T. Tamper-resistant mobile health using blockchaintechnology.JMIRMhealthUhealth2017,5,e111.

3. Vazirani, A.A.; O'Donoghue, O.; Brindley, D.; Meinert, E. Implementing Blockchainsfor E client Health Care: Systematic Review. J. Med. Internet Res. 2019, 21, e12439.[CrossRef]

4. Rouhani, S.; Butterworth, L.; Simmons, A.D.; Humphery, D.G.; Deters, R. Med Chain TM: A Secure Decentralized Medical Data Asset Management System. In Proceedings of the 2018 IEEE International Conference on Internet of Things (I Things) and IEEE Green Computing and Communications (Green Com) and IEEE Cyber, Physical and Social Computing(CPS Com) and IEEE Smart Data(Smart Data),Halifax,NS,Canada,30July–3August2018.

5. Vejendla, L. N., Bysani, B., Mundru, A., Setty, M., & Kunta, V. J. (2023). Score-based support vector machine for spam mail detection. Proceedings of the IEEE International Conference on Electronics, Computing and Communication Technologies (ICOEI), 915–920. https://doi.org/10.1109/ICOEI56765.2023.10125718

6. Anusha, P., Ravikiran, A., Lakshman Narayana, V., & Maddumala, V. R. (2020). Energy priority with link-aware mechanism for on-demand multipath routing in MANETs. Journal of Electrical Engineering and Automation, 29(3), 8979–8991.
7. Narayana, V. L., & Bharathi, C. R. (2017). Identity-based cryptography for mobile ad hoc networks. International Journal of Engineering and Technology Innovation, 95(5), 1173–1181
8. Narayana, V. L., & Midhunchakkaravarthy, D. (2020). A time interval-based blockchain model for detection of malicious nodes in MANET using network block monitoring node. Proceedings of the IEEE International Conference on Intelligent Computing and Robotics (ICIRCA), 852–857. https://doi.org/10.1109/ICIRCA48905.2020.9183256
9. Bharathi Vejendla, C. R., Narayana, L., & Ramesh, L. V. (2020). Secure data communication using Internet of Things. Journal of Advanced Research in Dynamic and Control Systems, 9(4), 3516–3520.
10. Narayana, V. L., Sujatha, V., Sri, K. S., Pavani, V., Prasanna, T. V. N., & Ranganarayana, K. (2023). Computer tomography image-based interconnected antecedence clustering model using deep convolutional neural network for prediction of COVID-19. Traitement du Signal, 40(4), 1689–1696. https://doi.org/10.18280/ts.400437
11. Patibandla, R. S. M. L., Rao, B. T., & Narayana, V. L. (2022). Prediction of COVID-19 using machine learning techniques. In Handbook of Machine Learning for Computational Biology and Bioinformatics (pp. 219–231). https://doi.org/10.1016/B978-0-12-824145-5.00007-1
12. Pavani, V., Sri, K. S., Krishna, P. S., & Narayana, V. L. (2021). Multi-level authentication scheme for improving privacy and security of data in decentralized cloud server. Proceedings of the IEEE International Conference on Systems and Electronics Engineering (ICOSEC), 391–394. https://doi.org/10.1109/ICOSEC51865.2021.9591698
13. Arepalli, P. G., Jairam Naik, K., & Rout, J. K. (2024). Aquaculture water quality classification with sparse attention transformers: Leveraging water and environmental parameters. In ACM International Conference Proceeding Series (pp. 318-325). https://doi.org/10.1145/3651781.3651829
14. Kumar, S. A., Babu, E. S., Nagaraju, C., & Gopi, A. P. (2015). An empirical critique of on-demand routing protocols against rushing attack in MANET. International Journal of Electrical and Computer Engineering, 5(5), 1102-1110. https://doi.org/10.11591/ijece.v5i5.pp1102-1110
15. Arepalli, G., Erukula, S. B., Gopi, A. P., & Nagaraju, C. (2016). Secure multicast routing protocol in MANETs using efficient ECGDH algorithm. International Journal of Electrical and Computer Engineering, 6(4), 1857-1865. https://doi.org/10.11591/ijece.v6i4.9941
16. Arepalli, P. G., Akula, M., Kalli, R. S., Kolli, A., Popuri, V. P., & Chalichama, S. (2022). Water quality prediction for salmon fish using Gated Recurrent Unit (GRU) model. In 2022 2nd International Conference on Computer Science, Engineering and Applications, ICCSEA 2022. https://doi.org/10.1109/ICCSEA54677.2022.9936539
17. Narayana, V. L., & Gopi, A. P. (2017). Visual cryptography for gray scale images with enhanced security mechanisms. Traitement du Signal, 34, 197-208. DOI: 10.3166/ts.34.197-208
18. Arepalli, P. G., Narayana, V. L., Venkatesh, R., & Kumar, N. A. (2019). Certified node frequency in social network using parallel diffusion methods. In generic des Systems Information, 24(1), 113-117. https://doi.org/10.18280/isi.240117
19. Peda Gopi, A., & Lakshman Narayana, V. (2017). Protected strength approach for image steganography. Traitement du Signal, 34(3-4), 175-181. https://doi.org/10.3166/TS.34.175-181
20. Narayana, V. L., Gopi, A. P., Anveshini, D., & Lakshmi, G. V. V. (2020). Enhanced path finding process and reduction of packet droppings in mobile ad-hoc networks. International Journal of Wireless and Mobile Computing, 18(4), 391-397. https://doi.org/10.1504/IJWMC.2020.108539
21. Vejendla, L. N., Naresh, A., & Arepalli, P. G. (2021). Traffic analysis using IoT for improving secured communication. In Innovations in the Industrial Internet of Things (IIoT) and Smart Factory (pp. 106-116). https://doi.org/10.4018/978-1-7998-3375-8.ch008
22. Kanumalli, S. S., Lavanya, K., Rajeswari, A., Samyuktha, P., & Tejaswi, M. (2023, February). A scalable network intrusion detection system using bi-lstm and cnn. In *2023 Third International Conference on Artificial Intelligence and Smart Energy (ICAIS)* (pp. 1-6). IEEE.
23. Kanumalli, S. S., Mantena, S. J., Kandula, S., Doppalapudi, K., & Atluri, T. (2022, May). Automated Irrigation Management System using IoT. In *2022 6th International Conference on Intelligent Computing and Control Systems (ICICCS)* (pp. 476-482). IEEE.

24. Kanumalli, S. S., Swathi, S., Sukanya, K., Yamini, V., & Nagalakshmi, N. (2022). Classification of dna sequence using machine learning. In *Soft Computing for Security Applications:*
25. Chaitanya, Kosaraju, et al. "Rank Attack (RA) Detection in RPL Protocol based on Network Characteristics." 2023 8th International Conference on Communication and Electronics Systems (ICCES). IEEE, 2023.
26. Kosaraju, Chaitanya, et al. "Mirchi crop yield prediction based on soil and environmental characteristics using modified RNN." 2023 IEEE International Students' Conference on Electrical, Electronics and Computer Science (SCEECS). IEEE, 2023
27. Chaitanya, Kosaraju, et al. "Ads Click-Through Rate prediction using Attention based LSTM Mechanism." 2024 IEEE International Students' Conference on Electrical, Electronics and Computer Science (SCEECS). IEEE, 2024.
28. Sujatha, V., Prasanthi, Y., Pravallika, C.H., ... Ayesha Banu, S.K., Sahithi, M.,K(23)
29. " A Computer Vision Method for Detecting the Lanes and Finding the Direction of Traveling the Vehicle *Lecture Notes in Networks and Systems"*, 2023, 612, pp. 373–382
30. Sri, L. Akhila, K. Manvitha, G. Amulya, I. Sai Sanjuna, and V. Pavani. "FBI crime analysis and prediction using machine learning." *Journal of Engineering Sciences* 11, no. 4 (2020): 441-448.
31. P. V, L. S. K, P. Vyshnavi A, M. Ch and S. B. G, "Students Community Portal using Machine Learning," *2023 Second International Conference on Electronics and Renewable Systems (ICEARS)*, Tuticorin, India, 2023, pp. 1109-1113, doi: 10.1109/ICEARS56392.2023.10085516.
32. Sirisha, Aswadati, et al. "Intrusion detection models using supervised and unsupervised algorithms-a comparative estimation." *International Journal of Safety and Security Engineering* 11.1 (2021): 51-58.
33. Krishna, KVSS Rama, et al. "Vehicle Number Plate Detection using Deep Learning." *2024 International Conference on Integrated Circuits and Communication Systems (ICICACS)*. IEEE, 2024.
34. Krishna, Komanduri Venkata Sesha Sai Rama, et al. "Classification of Glaucoma Optical Coherence Tomography (OCT) Images Based on Blood Vessel Identification Using CNN and Firefly Optimization." *Traitement du Signal* 38.1 (2021).
35. Rayachoti, Eswaraiah, Sudhir Tirumalasetty, and Silpa Chaitanya Prathipati. "Watermarking system for telemedicine based on FABEMD." *Multimedia Tools and Applications* 81.30 (2022): 44383-44404.
36. Chaitanya, P. Silpa, KV Narasimha Reddy, and G. Madhavi. "Effective Search of Color-Spatial Image Using Semantic Indexing." *International Journal of Computer Science, Engineering and Applications (IJCSEA) Vol* 2 (2012): 9-19.
37. Alapati, N., Prasad, B. V. V. S., Sharma, A., Kumari, G. R. P., Veeneetha, S. V., Srivalli, N., ... & Sahitya, D. (2022, November). Prediction of Flight-fare using machine learning. In *2022 International Conference on Fourth Industrial Revolution Based Technology and Practices (ICFIRTP)* (pp. 134-138). IEEE.
38. Alapati, N., Prasad, B. V. V. S., Sharma, A., Kumari, G. R. P., Bhargavi, P. J., Alekhya, A., ... & Nandini, K. (2022, November). Cardiovascular Disease Prediction using machine learning. In *2022 International Conference on Fourth Industrial Revolution Based Technology and Practices (ICFIRTP)* (pp. 60-66). IEEE.
39. Srikanth Kilaru " A Novel Approach to Human Iris Recognition And Verification Framework Using Machine Learning Algorithm" 2023 6th International Conference on Contemporary Computing and Informatics (IC3I),
40. DOI: 10.1109/IC3I59117.2023.10397886, ISBN Information:Electronic ISBN:979-8-3503-0448-0 print on Demand(PoD) ISBN:979-8-3503-0449-7
41. Srikanth Kilaru "Analytical models for collaborative autonomous mobile robot solutions in fulfillment centers" in Applied Mathematical Modelling, Volume 91, March 2021, Pages 438-457, https://doi.org/10.1016/j.apm.2020.09.059
42. Gopi, A. P., & Naik, K. J. (2022). An IoT model for fish breeding analysis with water quality data of pond using modified multilayer perceptron model. *2022 International Conference on Data Analytics for Business and Industry (ICDABI)*, 448-453. https://doi.org/10.1109/ICDABI56818.2022.10041617
43. Arepalli, P. G., & Naik, K. J. (2024). A deep learning-enabled IoT framework for early hypoxia detection in aqua water using lightweight spatially shared attention-LSTM network. *Journal of Supercomputing, 80*(2), 2718-2747. https://doi.org/10.1007/s11227-023-05580-x
44. Arepalli, P. G., & Naik, K. J. (2023). An IoT-based water contamination analysis for aquaculture using lightweight multi-headed GRU model. *Environmental Monitoring and Assessment, 195*(12), Article 1516. https://doi.org/10.1007/s10661-023-12126-4

45. Gopi, A. P., Gowthami, M., Srujana, T., Gnana Padmini, S., & Durga Malleswari, M. (2023). Classification of denial-of-service attacks in IoT networks using AlexNet. In *Smart Innovation, Systems and Technologies* (Vol. 316, pp. 349-357). https://doi.org/10.1007/978-981-19-5403-0_30

46. Bikku, T., Gopi, A. P., & Prasanna, R. L. (2019). Swarming the high-dimensional datasets using ensemble classification algorithm. In *Advances in Intelligent Systems and Computing* (Vol. 815, pp. 583-591). https://doi.org/10.1007/978-981-13-1580-0_56

47. Wu,H.T.; Tsai, C.W. Toward blockchains for health-care systems: Applying the bilinearpairing technology to ensure privacy protection and accuracy in data sharing. IEEEConsume.Electron.Mag.2018,7,65–71.[CrossRef]

48. Shen,B. ; Guo,J. ;Yang, Y.MedChain:Eclient HealthcareDataSharingviaBlockchain.Appl.Sci.2019,9,1207.[CrossRef]