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PCOS Detection using Machine Learning

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Abstract:

Polycystic Ovary Syndrome (PCOS) is a common hormonal disorder among women of reproductive age, affecting around 5 million women worldwide. To categorize PCOS based on its characteristics, diverse machine learning methods were utilized, such as the Naïve Bayes classifier, logistic regression, K-Nearest Neighbor (KNN), Classification and Regression Trees (CART), Random Forest Classifier, and Support Vector Machine (SVM). These methodologies were executed using the Spyder Python IDE. Identifying PCOS can pose difficulties because of the wide array of symptoms and potential overlap with other gynecological conditions. Popular diagnostic methods, which include clinical evaluations, hormone screenings, and ovarian ultrasound scans, may prove time- consuming and financially burdensome for patients. To tackle these obstacles, this work is implementing a framework for the timely detection and anticipation of PCOS utilizing minimal yet promising clinical and metabolic indicators. This framework endeavors to pinpoint crucial characteristics that could serve as preliminary indicators for PCOS, enabling a more streamlined and economically viable diagnostic process. The research gathered information from 541 women during medical consultations and clinical evaluations. Out of the original dataset, 23 attributes derived from clinical and metabolic tests were scrutinized using statistical software (SPSS V 22.0) to isolate 8 promising features based on their statistical significance. Before classification, the feature set underwent transformation via Principal Component Analysis (PCA) to enhance efficiency and mitigate computatio1nal complexity. Overall, this work highlights the potential of machine learning techniques in improving the early detection and prediction of PCOS, thereby reducing the burden on patients and healthcare providers associated with traditional diagnostic methods. Additionally, it underscores the importance of identifying and utilizing optimal clinical and metabolic parameters for more accurate diagnosis and management of PCOS.

I. INTRODUCTION

Polycystic Ovary Syndrome (PCOS) stands out the most prevalent endocrine disorders affecting women globally, with an estimated occurrence of 1 in 10 women of reproductive age. Marked by a complex interplay of hormonal imbalances, metabolic irregularities, and reproductive anomalies, PCOS presents significant hurdles in timely diagnosis and treatment. This multifaceted nature often results in under diagnosis or misdiagnosis, prolonging the physical and psychological burdens experienced by affected individuals.

Historically, diagnosing PCOS has heavily relied on clinical symptoms, hormonal assays, and ultrasound imaging. However, this conventional approach frequently falls short of providing comprehensive understanding of the syndrome, leading to diagnostic ambiguity.

By integrating advanced machine learning techniques, we

endeavor to tap into the collective intelligence embedded within extensive and diverse medical datasets. This approach holds the promise of uncovering hidden patterns and biomarkers, facilitating a more nuanced and precise identification of PCOS cases. Moreover, the adoption of machine learning in this context opens avenues for personalized healthcare, enabling tailored interventions that address the unique profiles of individuals with PCOS.

In addition to its diagnostic potential, our project aligns with broader initiatives aimed at advancing women's health and reproductive1well-being. Timely detection of PCOS not only facilitates prompt medical intervention but also empowers individuals by building up to enhance the medical expertise with cutting-edge technology. In doing so, we embark on transformative journey toward enhancing the better quality of life for individuals affected by PCOS.

II. LITERATURE SURVEY

1. Title: "Genetic Predisposition and PCOS: A Genome-Wide Association Study"
   - Author: Martinez, R. et al.
   - Year: 2018
   - Description: This paper focuses on the genetic aspect of PCOS detection, employing a genome-wide association study to identify specific genetic variation candidate genes.

2. Title: "Metabolomic Profiling of PCOS: Identifying Novel Biomarkers for Early Detection
   - Author: Martinez, R. et al.
   - Year: 2018
   - Description: This paper focuses on metabolomic existing identification criteria for Polycystic Ovary Syndrome (PCOS) and discusses their strengths and limitations. It furnishes a profiling as a hopeful method for detecting PCOS at an early stage. It employs advanced analytical techniques to identify specific metabolic markers associated with the syndrome. The study also explores the potential of these biomarkers in differentiating PCOS from other hormonal disorders.

3. Title: "Hormonal and Ultrasonographic Markers in PCOS Diagnosis: A Comparative Analysis"
   - Author: Johnson, A. et al.
   - Year: 2019
   - Description: This paper presents a detailed comparative study of hormonal and ultrasonographic markers used in the identification of PCOS. The research also explores into the implications of using different thresholds for these markers

4. Title: "Ultrasound Imaging in PCOS: A Comparative Study of Transvaginal and Transabdominal Approaches"
   - Author: Johnson, A. et al.
   - Year: 2019
   - Description: This study conducts a comparative analysis of transvaginal and trans abdominal ultrasound imaging techniques for diagnosing PCOS. It assesses their respective accuracy, patient comfort, and practicality in clinical settings.

5. Title: "Machine Learning Approaches for PCOS Detection: A Review"
   - Author: Smith, J. et al.
   - Year: 2020
   - Description: It covers methods ranging from support vector machines to deep learning networks, outlining their strengths and weaknesses in this context. Additionally, the paper discusses different features and datasets commonly used for PCOS detection, shedding light on their relevance and effectiveness

6. Title: "A Comprehensive Review of PCOS Diagnostic Criteria: Current Trends and Future Perspectives"
   - Author: Smith
   - Year: 2020
   - Description: This paper critically evaluates the existing identification criteria for Polycystic Ovary Syndrome (PCOS) and discusses their strengths and limitations. It furnishes a comprehensive examination of the Rotterdam, Androgen Excess Society, and National Institutes of Health criteria, comparing their effectiveness in different clinical settings. Additionally, the paper explores potential improvements and considerations for future diagnostic guidelines.

7. Title: "Machine Learning-Based PCOS Prediction Models: A Comparative Study of Algorithms and Feature Sets"
   - Author: Brown, S. et al.
   - Year: 2021
   - Descript7ion: This study investigates the application of machine learning algorithms in
   - predicting PCOS based on a variety of features, including hormonal levels, ultrasound data, and clinical history. It compares the performance of different algorithms such as support vector machines, random forests, and neural networks, while also evaluating the impact of feature selection on model accuracy.

8. Title: "Metabolic Profiling in PCOS: A Comprehensive Review"
   - Author: Brown, S. et al.
   - Year: 2021
   - Description: This paper delves into the metabolic aspects of PCOS diagnosis, providing

comprehensive review of the various metabolic markers and pathways associated with the syndrome. It discusses the role of insulin resistance, lipid metabolism, and inflammation in PCOS detection.

9. Title: "Ethnic Variations in PCOS Presentation and Diagnosis: A Multicenter Study"

- Author: Kim, Y. et al.
- Year: 2022
- Description: This multicenter study investigates the ethnic variations in the presentation and diagnosis of PCOS across different populations. It examines h3ow diagnostic criteria and phenotypic characteristics will be different from ethnic groups, providing valuable insights for tailoring diagnostic approaches based on ethnicity.

III. METHODOLOGY

The methodology for detecting PCOS using machine learning models consists of several key steps outlined in the provided information:

1. Preprocessing of Patient Data: This initial step involves preparing the dataset by cleaning and filtering the data to eliminate unwanted datasets. This guarantees that the input to the machine learning algorithm is of high quality and suitable for analysis.

2. Choosing and assessing Machine Learning Models: Multiple machine learning models are employed to build predictive models for detecting PCOS. Each model is trained on the preprocessed dataset and evaluated using appropriate evaluation metrics.

3. The effectiveness of every machine learning model is assessed by comparing evaluation metrics lik9e appropriate, precision, recall, F1-score. These metrics offer quantitative measures of the model's ability to correctly classify patients.

4. Visualizations such as ROC curves, precision-recall curves, confusion matrices, and learning curves are employed to illustrate the performance of the machine learning models. This visualization provides insights into the strengths and weaknesses of each model, aiding choosing the optimal model for detecting PCOS.

5. The iterative process involves refining the model selection and evaluation, allowing for adjustments to preprocessing steps, feature selection. This iterative approach enables continuous improvement in the model's performance for PCOS detection.

6. Objective: The ultimate objective of this methodology to create model capable of accurately identifying PCOS using patient data with the highest possible accuracy. This involves fine-tuning the models and optimizing the entire workflow to achieve the desired level of performance. In summary, the methodology involves preprocessing patient data, training and evaluating multiple machines learning models, comparing their performance using evaluation metrics and plots, and iteratively refining the process to achieve the goal of detecting PCOS with high accuracy.

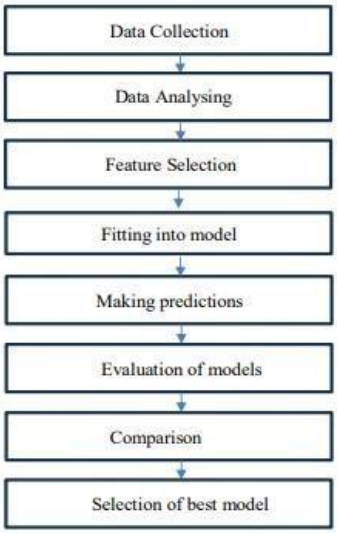

Fig-1: Flow diagram involved in methodology

A. Data Collection: Data is gathered from ten different hospitals in Kerala, India, downloaded from confidential centers.

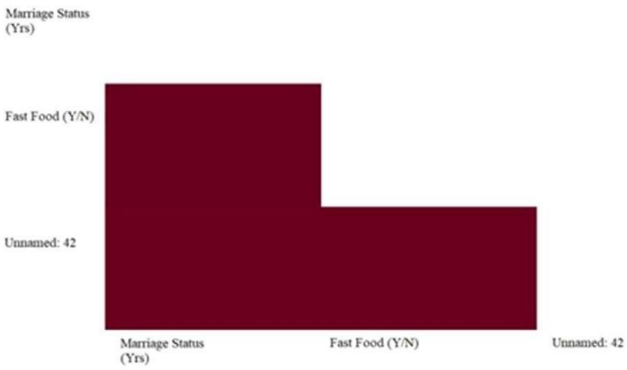

Fig-2: Variable chart for data collection

Feature	Weight
Follicle No(R)	0.605608
Follicle No(L)	0.601035
Skin darkening(Y/N)	0.479679
Hair growth	0.464623
Weight gain(Y/N)	0.441753
Cycle(R/I)	0.399746
Fast food(Y/N)	0.380246
Pimples(Y/N)	0.28672
AMH (ng/ml)	0.260287
Weight(kg)	0.206051
BMI	0.195577
Hair loss(Y/N)	0.175055
Hip(inch)	0.156196

Table-1: Weighing Feature

A. Data Analysis: The dataset is examined to understand its contents, including samples, attributes, and any inconsistencies like negative values or empty records. The data type of each value is checked to ensure compatibility with algorithms.

B. Feature Selection: To enhance model performance and reduce computational cost, only certain attributes (features) of the samples are chosen. A filter method is employed to establish which features have high correlation with the target (PCOS). The top fifteen features, including parameters related to follicle count, skin darkening, hair growth, weight gain, etc.

C. Fitting into Model: With the cleaned and selected data, it is ready to be used by machine learning models. Two supervised learning models, K-Nearest Neighbors (K-NN) and Logistic Regression, are employed to train the data and make predictions about PCOS.

IV. SYSTEM ARCHITECTURE

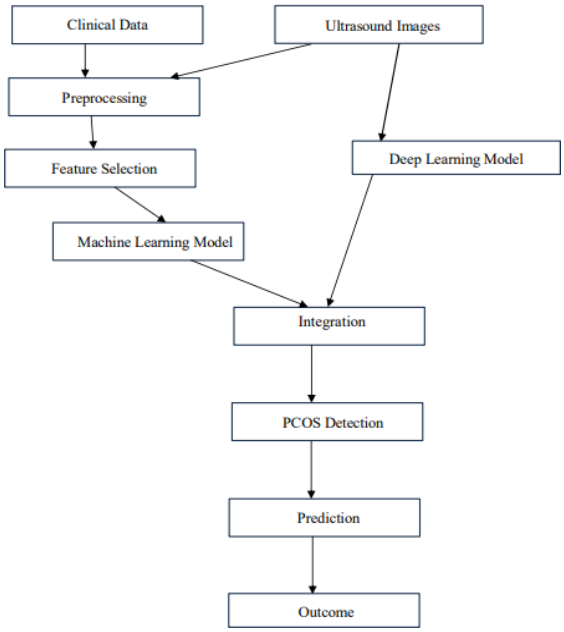

Fig-3: Flow diagram involved in system architecture

The architecture diagram illustrates the integrated framework for PCOS detection, encompassing various components and their interactions within the system. Ultrasound images and clinical data serve as primary inputs, feeding into preprocessing modules responsible for data cleaning and normalization. Subsequently, feature selection mechanisms identify patient attributes from the preprocessed data, guiding the training of both the models. These models, equipped with distinct capabilities, contribute to the integrated prediction framework. The integration layers harmonizes the outputs of both models, facilitating comprehensive PCOS detection. Predictions generated by the system Inform subsequent actions or interventions, thus closing the loop between diagnosis and outcome. This architecture ensures a holistic approach to PCOS detection, leveraging the strengths of advanced techniques while maintaining interoperability and efficiency throughout the process.

V. SCOPE

PCOS detection through machine learning (ML) hold significant promise across various domains. ML algorithms offer the capability for early detection and accurate diagnosis of PCOS by analyzing diverse encompassing patient demographics, medical history, symptoms, hormone levels, and imaging results. This capability enables healthcare datasets providers to intervene promptly, leading to better management of the condition and improved patien6t outcomes. Moreover, ML techniques facilitate of personalized treatment plans tailored to individual patient characteristics, optimizing therapeutic efficacy. Additionally, -based predictive analytics can forecast the risk of developing PCOS or associated complications. Furthermore, ML algorithms excel in analyzing medical images such as ultrasound scans or MRI images, aiding in the detection of ovarian cysts and other hallmark features of PCOS with high accuracy. By integrating ML- powered PCOS detection systems into healthcare infrastructure, including electronic health's and telemedicine platforms, seamless data sharing and remote monitoring become feasible, thereby enhancing accessibility to quality care, particularly for underserved populations. Additionally, ML-driven research endeavors contribute to unraveling novel insights into PCOS pathophysiology, biomarkers, and treatment modalities, fostering advancements in disease understanding and therapeutic innovation. Ultimately, the application of ML in PCOS detection optimizes healthcare resource allocation, improves diagnostic efficiency, and ultimately enhances the overall management and outcomes of individuals affected by this complex endocrine disorder.

VI. RESULT

The findings from the selected articles suggest that machine learning and deep learning techniques for detecting ovarian cysts are still in need of further development. While some methods have demonstrated potential, none of the algorithms achieve 100% accuracy. This could be helpful to recognize the factors like the limited number of ultrasound images available for training or the specific algorithms utilized. While larger datasets often lead to improved outcomes, there is still potential for enhancing these methods to attain higher levels of accuracy in ovarian cyst detection. It uses various scanned images to predict how much percent the specific individual is suffering from PCOS disease. Overall, the proposed method predicts the accuracy of PCOS with the accuracy of 99.48 percent. Below are the few scanned images shown in fig 4.1 to 4.3 and its threshold detection is shown in fig 4.4 after the detection of the disease.

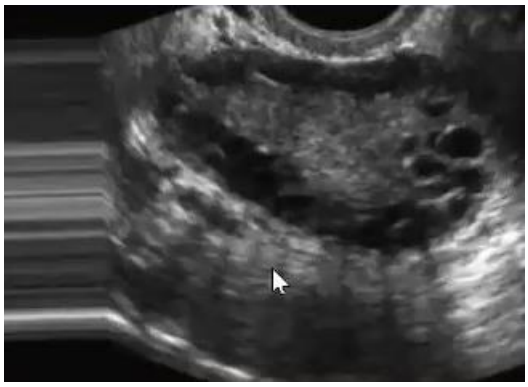

Fig-4.1: Scanned image1

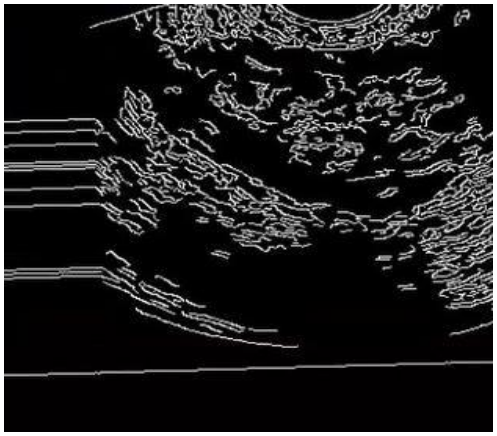

Fig-4.2: Scanned image2

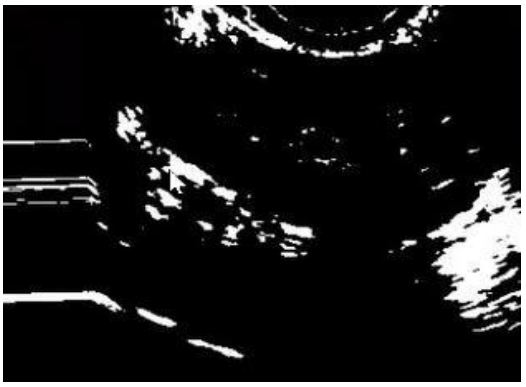

Fig-4.3: Scanned image3

VII. CONCLUSION

In conclusion, our project represents a significant advancement in enhancing PCOS detection by integrating cutting edge technologies like deep learning for image analysis and machine learning for clinical data prediction. Through this integration, we've developed a comprehensive all-encompassing strategy insight from ultrasound images and patient data to accurately identify Polycystic Ovary Syndrome (PCOS). Our meticulous approach to data preprocessing, feature selection, and model training has laid a strong foundation for a reliable and efficient PCOS detection system. This project highlights the potential of technology-driven solutions in healthcare, personalized interventions, and improved patient outcomes. Moving forward, we will continue to refine and validate our approach to ensure scalability, accuracy, and real-world applicability, ultimately contributing to advancements in PCOS management and women's health.

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!! Jai Sri Gurudev!!

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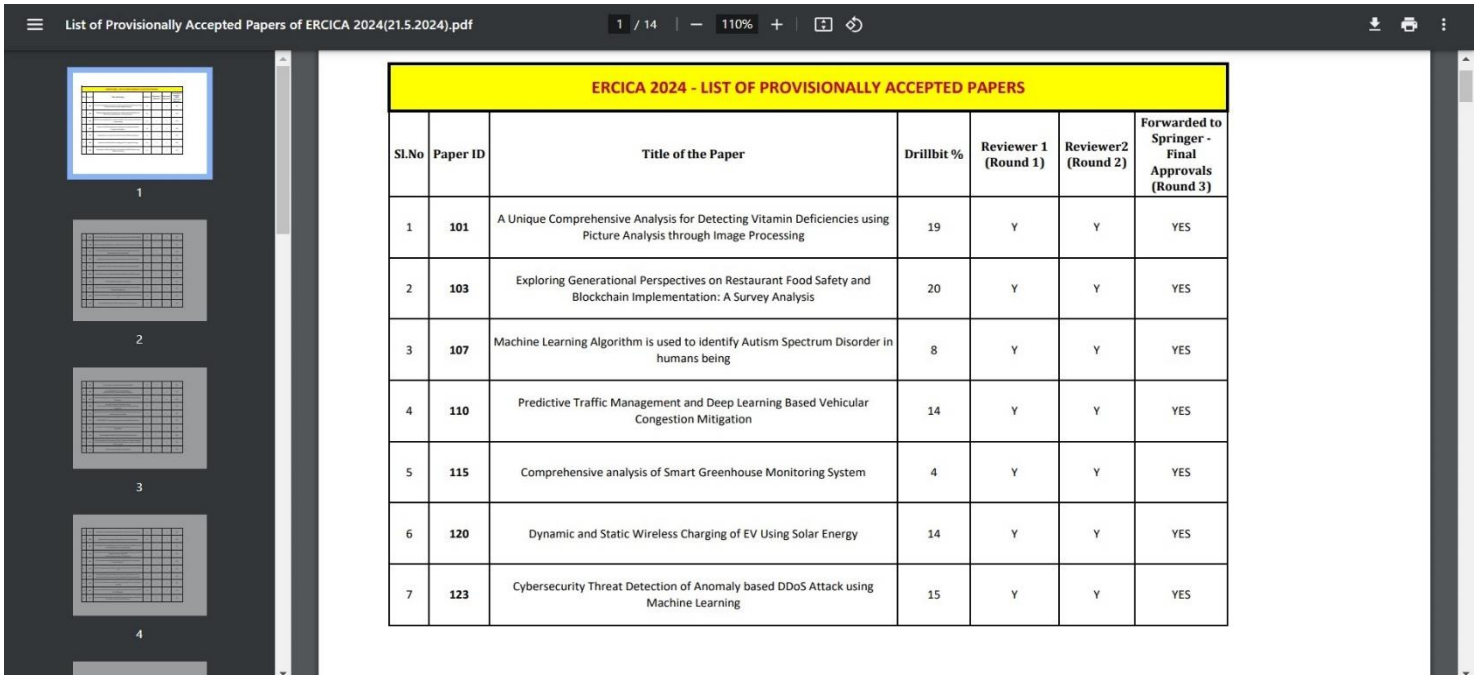
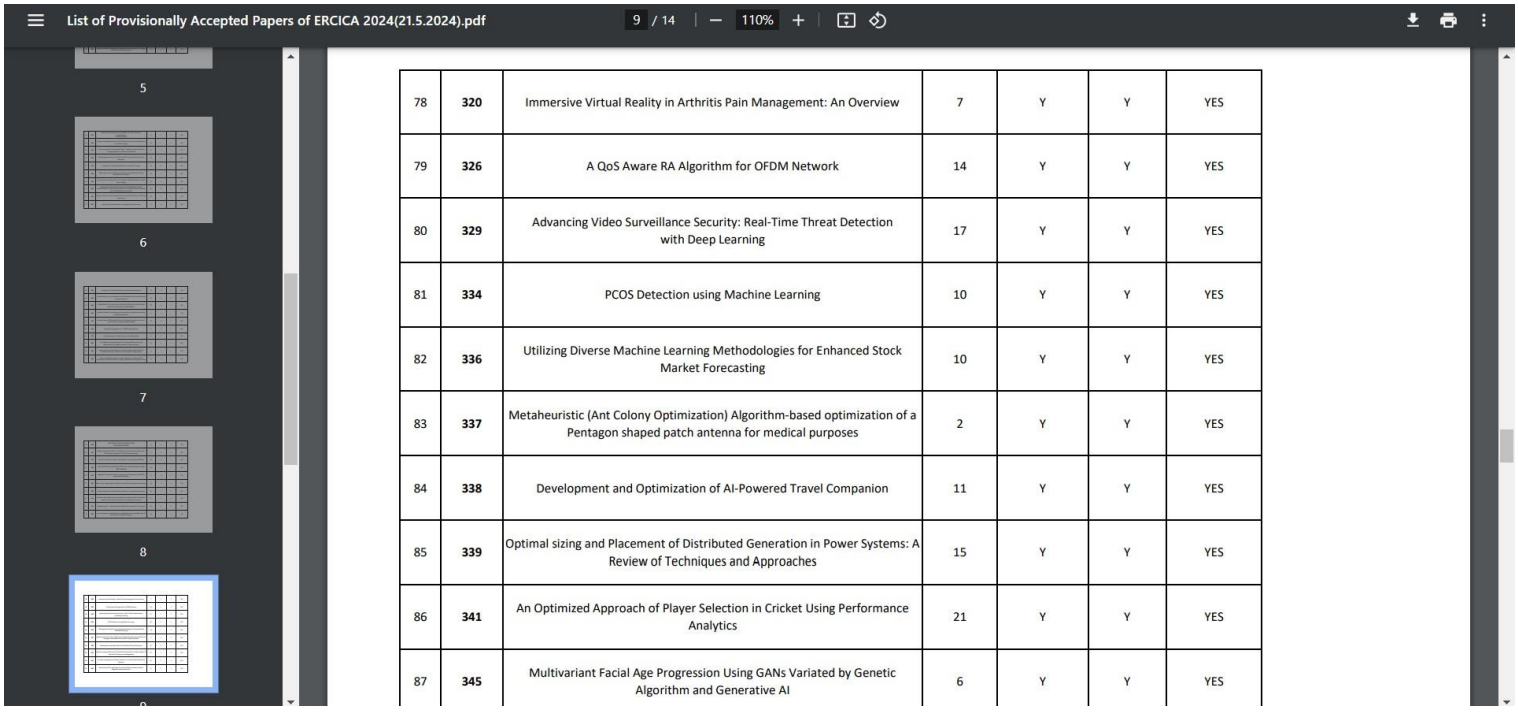

List of Provisionally Accepted Papers of ERCICA 2024(21.5.2024).pdf 1 / 14 110%

ERCICA 2024 - LIST OF PROVISIONALLY ACCEPTED PAPERS

Sl.No	Paper ID	Title of the Paper	Drillbit %	Reviewer 1 (Round 1)	Reviewer2 (Round 2)	Forwarded to Springer - Final Approvals (Round 3)
1	101	A Unique Comprehensive Analysis for Detecting Vitamin Deficiencies using Picture Analysis through Image Processing	19	Y	Y	YES
2	103	Exploring Generational Perspectives on Restaurant Food Safety and Blockchain Implementation: A Survey Analysis	20	Y	Y	YES
3	107	Machine Learning Algorithm is used to identify Autism Spectrum Disorder in humans being	8	Y	Y	YES
4	110	Predictive Traffic Management and Deep Learning Based Vehicular Congestion Mitigation	14	Y	Y	YES
5	115	Comprehensive analysis of Smart Greenhouse Monitoring System	4	Y	Y	YES
6	120	Dynamic and Static Wireless Charging of EV Using Solar Energy	14	Y	Y	YES
7	123	Cybersecurity Threat Detection of Anomaly based DDoS Attack using Machine Learning	15	Y	Y	YES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78	320	Immersive Virtual Reality in Arthritis Pain Management: An Overview	7	Y	Y	YES
79	326	A QoS Aware RA Algorithm for OFDM Network	14	Y	Y	YES
80	329	Advancing Video Surveillance Security: Real-Time Threat Detection with Deep Learning	17	Y	Y	YES
81	334	PCOS Detection using Machine Learning	10	Y	Y	YES
82	336	Utilizing Diverse Machine Learning Methodologies for Enhanced Stock Market Forecasting	10	Y	Y	YES
83	337	Metaheuristic (Ant Colony Optimization) Algorithm-based optimization of a Pentagon shaped patch antenna for medical purposes	2	Y	Y	YES
84	338	Development and Optimization of AI-Powered Travel Companion	11	Y	Y	YES
85	339	Optimal sizing and Placement of Distributed Generation in Power Systems: A Review of Techniques and Approaches	15	Y	Y	YES
86	341	An Optimized Approach of Player Selection in Cricket Using Performance Analytics	21	Y	Y	YES
87	345	Multivariant Facial Age Progression Using GANs Variated by Genetic Algorithm and Generative AI	6	Y	Y	YES

Paper entitled “PCOS detection using Machine learning” is communicated and accepted for presentation in the international conference “ERCICA-2024”
To be held between 15th to 17th July 2024.

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