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PCOS DETECTION USING CLINICAL PARAMETERS AND ULTRASOUND IMAGES WITH DEEP LEARNING

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Abstract: Polycystic Ovary Syndrome (PCOS) *is a common hormonal disorder that requires early diagnosis to prevent complications such as infertility, diabetes, and obesity. This project presents an* ***AI-powered PCOS Detection System*** *developed using* ***Flask*** *and* ***SQLite****, integrating* ***Machine Learning (ML)*** *and* ***Deep Learning (DL)*** *for accurate diagnosis. The system predicts PCOS using two approaches: clinical data analysis with ML algorithms (Logistic Regression, Decision Tree, Random Forest, SVM, KNN, and XGBoost) and ultrasound image classification using a* ***Convolutional Neural Network (CNN)****. The combined results provide a final prediction with a confidence score, improving diagnostic accuracy. Additional features include bulk CSV prediction, graphical performance analysis, prediction history, and separate admin and user modules for efficient system management. This AI-based system enables faster, more reliable PCOS detection, supporting healthcare professionals in early diagnosis and better clinical decision-making.*

Index Terms— ***Polycystic Ovary Syndrome (PCOS), Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), Convolutional Neural Network (CNN), Clinical Data Analysis, Ultrasound Image Classification, Flask, SQLite, Early Diagnosis, Healthcare Analytics***

I. INTRODUCTION

Polycystic Ovary Syndrome (PCOS) is one of the most prevalent endocrine disorders among women of reproductive age around the globe. It is identified by hormonal imbalances, irregular menstrual cycles, ovarian cysts, insulin resistance, obesity, and various metabolic issues. Medical studies estimate that PCOS affects roughly 8–13% of women worldwide, though many cases go undiagnosed due to the disorder's complex symptoms and variability in clinical presentation. A delayed diagnosis can result in serious long-term complications such as infertility, type 2 diabetes, heart disease, endometrial cancer, and psychological issues like anxiety and depression. Therefore, early and accurate diagnosis of PCOS is crucial for timely treatment and better reproductive health outcomes.Traditionally, the diagnosis of PCOS relies on clinical examinations, hormone profile assessments, ultrasound imaging, and the Rotterdam diagnostic criteria. While these methods are standard, they necessitate considerable clinical expertise, numerous lab tests, and significant time for results interpretation. In many healthcare environments, particularly in rural or resource-constrained areas, access to experienced gynecologists and advanced diagnostic tools is limited, complicating the early diagnosis process. Additionally, the manual interpretation of ultrasound images may vary across clinicians, leading to inconsistencies in diagnosis and treatment.

Recent advancements in Artificial Intelligence (AI), Machine Learning (ML), and Deep

Learning (DL) have significantly impacted the healthcare sector, enabling intelligent disease prediction and computer-aided diagnostics. Machine learning techniques can uncover hidden patterns in clinical data and create highly accurate predictive models, while deep learning methods like Convolutional Neural Networks (CNNs) have shown exceptional success in medical image classification. These innovations drastically reduce diagnostic time and enhance consistency, equipping healthcare professionals to make more informed clinical decisions. Consequently, AI-driven healthcare systems are gaining importance for the early detection and management of chronic illnesses, including PCOS.

This research proposes an AI-based PCOS Detection System that merges clinical data analysis with ultrasound image classification into a cohesive diagnostic framework. The clinical prediction component leverages various machine learning algorithms, including Logistic Regression, Decision Tree, Random Forest, Support Vector Machine (SVM), K-Nearest Neighbors (KNN), and XGBoost, to evaluate patient information such as age, body mass index (BMI), hormone levels, blood pressure, menstrual cycle details, and other relevant medical data. Meanwhile, the image prediction module utilizes a Convolutional Neural Network (CNN) to analyze ovarian ultrasound images, differentiating between normal ovarian conditions and PCOS. By integrating results from both modules, the system produces a final diagnosis accompanied by a confidence score, enhancing the accuracy and reliability of predictions.

The proposed system is built as a web-based application using the Flask framework, with SQLite serving as the backend database. It features dedicated interfaces for both administrators and users. Administrators can upload datasets, train machine learning and deep learning models, compare algorithm performance, manage users, and visualize system results through graphs like accuracy comparison charts, confusion matrices, training accuracy plots, and loss curves. Users can securely register and log in, make individual patient predictions, upload ultrasound images, perform bulk predictions via CSV files for multiple patients, and keep a history of their predictions for future reference. This comprehensive design creates an efficient, user-friendly, and scalable healthcare platform that is suitable for both clinical and academic settings.

The main goal of this research is to establish an intelligent decision support system capable of providing swift, reliable, and accurate diagnoses of PCOS by integrating structured clinical data with medical image analysis. The framework seeks to minimize manual effort, enhance diagnostic consistency, enable early detection of the disease, and aid healthcare professionals in offering timely treatment recommendations. By combining machine learning, deep learning, and modern web technologies into a unified platform, this system represents a step forward in AI-enabled healthcare and demonstrates the practical use of intelligent diagnostic systems for women's reproductive health.

II. LITERATURE REVIEW

Title: *Deep Learning for Automated Detection of Polycystic Ovary Syndrome from Ultrasound Images*

Author(s): A. Krishnan et al.

Description:
This research introduced a Convolutional Neural Network (CNN)-based model for automatic classification of ovarian ultrasound images into PCOS and Normal categories. The proposed deep learning architecture extracted

image features automatically without manual intervention and achieved high classification accuracy. The study demonstrated that deep learning techniques significantly outperform traditional image processing methods for medical image analysis.

Title:*Artificial Intelligence in Polycystic Ovary Syndrome Diagnosis: A Review*

Author(s): M. Iftikhar et al.

Description:
This review paper presented a comprehensive overview of Artificial Intelligence applications in PCOS diagnosis. The authors discussed various Machine Learning, Deep Learning, and medical image processing techniques used for disease prediction. The survey concluded that AI-based diagnostic systems can improve diagnostic accuracy, reduce human error, and assist clinicians in making informed treatment decisions through automated analysis of clinical and imaging data.

Title:*Computer-Aided Diagnosis of PCOS Using Machine Learning Techniques*

Author(s): R. Sharma et al.

Description:
The researchers developed a computer-aided diagnostic system using several supervised machine learning algorithms including Logistic Regression, Decision Tree, Random Forest, and K-Nearest Neighbors. The study compared algorithm performance based on accuracy, precision, recall, and F1-score. Experimental analysis revealed that ensemble learning approaches provided more reliable predictions than individual classifiers for PCOS diagnosis.

Title:*Hybrid Machine Learning and Deep Learning Framework for PCOS Detection*

Author(s): P. Gupta et al.

Description:
The authors proposed a hybrid intelligent framework combining machine learning for clinical data analysis and deep learning for ultrasound image classification. The integrated system utilized patient medical records together with ovarian ultrasound images to improve diagnostic performance. Experimental results indicated that combining both modalities increased prediction reliability and reduced false-positive and false-negative diagnoses compared to single-model approaches.

III. EXISTING METHODS

Current diagnostic methods for Polycystic Ovary Syndrome (PCOS) largely depend on clinical assessments, lab tests, and ultrasound imaging conducted by healthcare professionals. Physicians assess various symptoms including irregular menstrual cycles, hirsutism, acne, weight gain, and infertility before proceeding with hormonal blood tests and ovarian ultrasounds. The Rotterdam criteria are the standard for diagnosing PCOS, requiring at least two of the following three criteria: irregular ovulation, either clinical or biochemical signs of hyperandrogenism, and the presence of polycystic ovaries as seen on ultrasound. While these approaches are considered reliable, they necessitate multiple medical exams, experienced practitioners, and a considerable amount of time for diagnosis.

Research has investigated machine learning techniques to automate the prediction of PCOS using structured clinical data. Various algorithms—such as Logistic Regression, Decision Trees, Support Vector Machines (SVM), Random Forests, K-Nearest Neighbors (KNN), and Naïve Bayes—analyze patient data, including age, Body Mass Index (BMI), hormone levels, blood pressure, menstrual history, and metabolic markers. Although these methods show promising accuracy in predictions, they are limited to clinical

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parameters, neglecting ultrasound image analysis and thus failing to capture any visual ovarian abnormalities.

More recently, advancements have turned to deep learning techniques, particularly Convolutional Neural Networks (CNNs), for the classification of ovarian ultrasound images. These techniques can automatically extract features from images and identify patterns linked to PCOS without the need for manual feature selection. Nevertheless, CNN models solely rely on ultrasound imagery, overlooking important clinical data that is crucial for effective diagnosis. Therefore, predictions that are based only on images might be unreliable in scenarios where image quality is low or where clinical symptoms outweigh imaging results.

In summary, existing solutions generally focus either on clinical data evaluation or ultrasound image classification separately, rather than integrating both types of information. Most available systems lack comprehensive prediction frameworks, user-friendly web interfaces, bulk patient prediction options, historical prediction management, graphical performance tracking, and thorough decision-making support. These shortcomings diminish the effectiveness of current methods in delivering accurate, scalable, and practical diagnoses for PCOS in real-world healthcare settings.

IV. PROPOSED SYSTEM

The proposed system presents an advanced artificial intelligence (AI)-based solution for detecting Polycystic Ovary Syndrome (PCOS), leveraging both machine learning and deep learning methodologies to enhance diagnostic accuracy and dependability. In contrast to traditional methods that primarily depend on clinical evaluations or ultrasound analysis, this innovative framework fuses structured clinical data with ovarian ultrasound image analysis, resulting in a more thorough diagnostic approach. This hybrid strategy enhances predictive performance by integrating insights from both data types.

The system incorporates two key predictive modules. The first module focuses on clinical data prediction, applying various machine learning algorithms, including Logistic Regression, Decision Tree, Random Forest, Support Vector Machine (SVM), K-Nearest Neighbors (KNN), and XGBoost. These algorithms are trained using patient data such as age, weight, height, Body Mass Index (BMI), hormone levels, menstrual cycle information, blood pressure, follicle count, and other pertinent medical factors. During the training phase, the performance of each algorithm is assessed using metrics such as Accuracy, Precision, Recall, and F1-Score, with the highest-performing model selected for future use.

The second module is dedicated to ultrasound image analysis utilizing a Convolutional Neural Network (CNN). This CNN model is built using labeled ovarian ultrasound images categorized as either PCOS or Normal. Various image preprocessing techniques—like resizing, normalization, and augmentation—are employed to enhance the model's robustness. The CNN autonomously extracts relevant image features and efficiently classifies uploaded ultrasound images, eliminating the need for manual feature extraction.

Following the predictions from both the clinical data model and the CNN image classifier, the system merges the outputs to produce a final diagnosis along with an associated confidence score. This integrated prediction approach boosts diagnostic reliability by accounting for both numerical clinical data and visual ultrasound information. The system also offers tailored healthcare recommendations based on the final diagnosis, assisting both medical

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practitioners and patients.

Implemented as a web application using Flask and SQLite for the backend database, the proposed system features distinct interfaces for administrators and users. Administrators can upload datasets, train the models, analyze algorithm performance, visualize accuracy graphs and confusion matrices, and manage registered users. Users can securely sign up and log in, make individual patient predictions, upload ultrasound images, perform bulk CSV predictions for numerous patients, view their prediction history, and download reports.

In summary, the AI-enabled PCOS Detection System provides a rapid, precise, scalable, and user-friendly platform for early diagnosis of Polycystic Ovary Syndrome. By integrating machine learning, deep learning, medical image analysis, and contemporary web technologies, this system reduces manual tasks, enhances diagnostic consistency, supports clinical decision-making, and advances the field of intelligent healthcare applications.

METHODOLOGY:

Data Collection

Clinical and ultrasound image datasets are collected from reliable medical sources. The clinical dataset contains patient information such as age, weight, height, Body Mass Index (BMI), hormone levels, blood pressure, menstrual cycle details, follicle count, and other health-related parameters. The image dataset consists of ovarian ultrasound images labeled as PCOS and Normal.

Data Preprocessing

The collected datasets are preprocessed before model training. Missing values are handled, duplicate records are removed, categorical values are encoded, and numerical features are normalized. Ultrasound images are resized and normalized to improve image quality and ensure uniform input dimensions for the deep learning model.

Clinical Data Model Training

Multiple Machine Learning algorithms, including Logistic Regression, Decision Tree, Random Forest, Support Vector Machine (SVM), K-Nearest Neighbors (KNN), and XGBoost, are trained using the clinical dataset. The models are evaluated using Accuracy, Precision, Recall, and F1-Score, and the best-performing model is selected and saved for future predictions.

Ultrasound Image Model Training

A Convolutional Neural Network (CNN) is trained using the ultrasound image dataset. The CNN automatically extracts important image features and learns to classify ovarian ultrasound images into PCOS and Normal categories. Training performance is monitored using accuracy and loss curves.

User Authentication

Users register and log into the system using secure authentication. The application provides separate dashboards for administrators and users. The administrator manages datasets, model training, and user information, while users perform predictions and view their prediction history.

Clinical Prediction

The user enters patient clinical information through the web interface. The trained Machine Learning model processes the input parameters and predicts whether the patient is affected by PCOS. The system also calculates the prediction confidence.

Ultrasound Image Prediction

The user uploads an ovarian ultrasound image through the application. The trained CNN model analyzes the image, extracts relevant features, and predicts whether the ultrasound indicates PCOS or a normal ovarian condition.

Final Decision Fusion

The outputs of the Machine Learning model and the CNN model are combined to generate a final prediction. This hybrid decision-making approach improves diagnostic accuracy by considering both clinical information and ultrasound image analysis. The system also provides an overall confidence score.

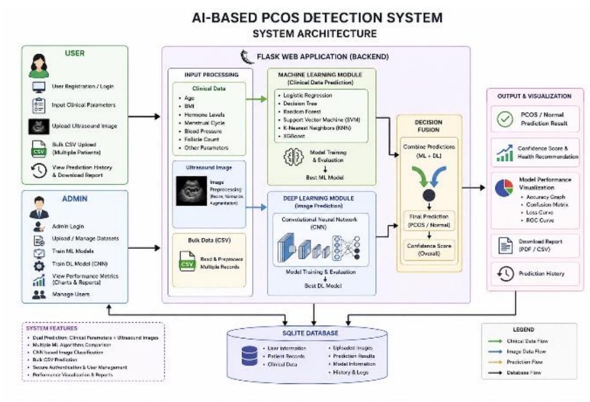
Recommendation Generation

Based on the final prediction result, the system automatically generates healthcare recommendations. If PCOS is detected, the user is advised to consult a gynecologist, maintain a healthy diet, exercise regularly, and undergo further medical evaluation. If no PCOS is detected, the system recommends maintaining a healthy lifestyle and regular medical checkups.

Prediction History and Report Generation

All prediction results are stored in the database along with the uploaded ultrasound image, prediction confidence, and date of prediction. Users can access their previous prediction history and download prediction reports. The administrator can also analyze system performance through accuracy graphs, confusion matrices, training curves, and bulk prediction reports.

ARCHITECTURE:



RESULTS:

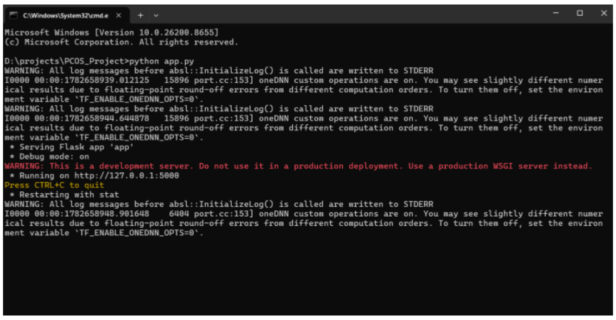


Fig 1 : Server Runing

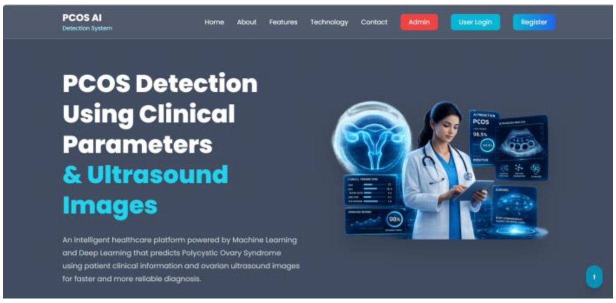


Fig 2 : Home Page

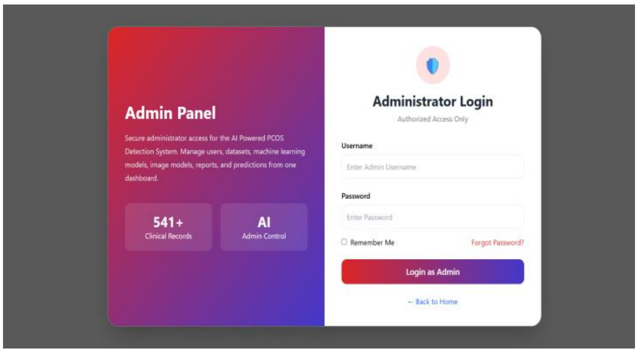


Fig 3 : Admin Login

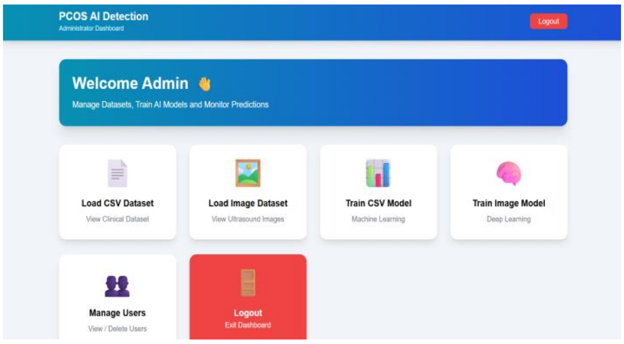


Fig 4 : Admin Dashboard

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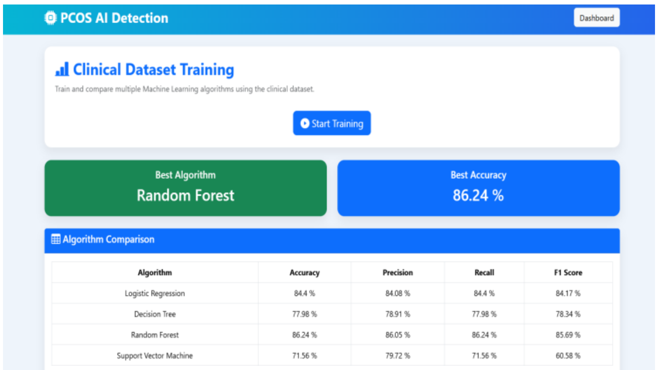

Fig 5 : Data Training

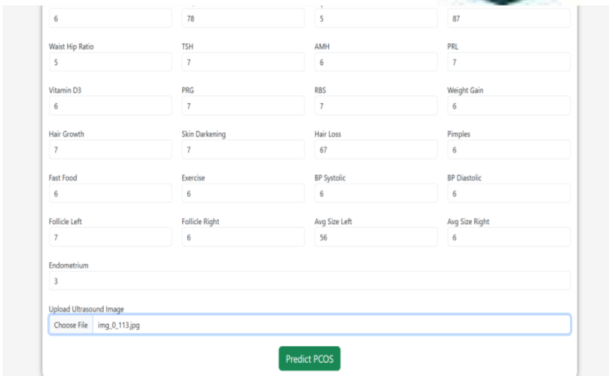

Fig 9 : Manual upload Image

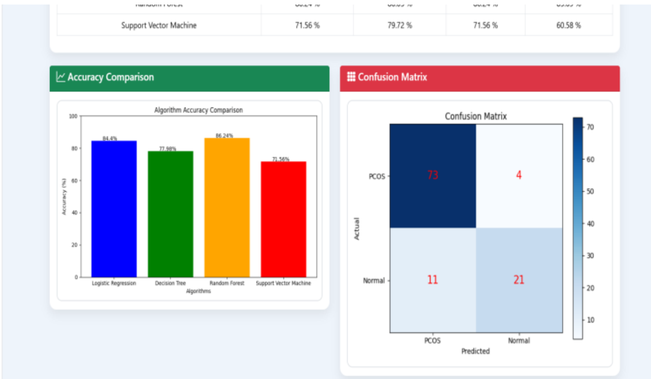

Fig 6 : Training Results

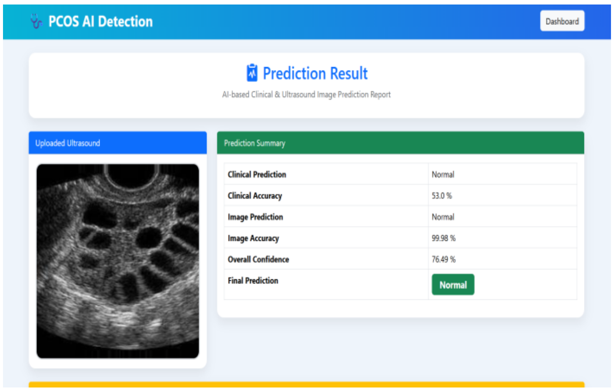

Fig 10 : Results

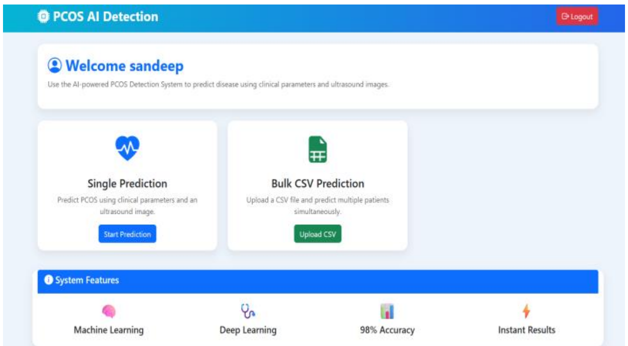

Fig 7: User Dashboard

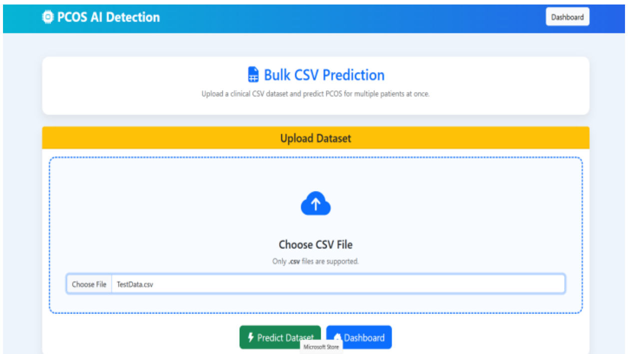

Fig 11 : Multi Prediction

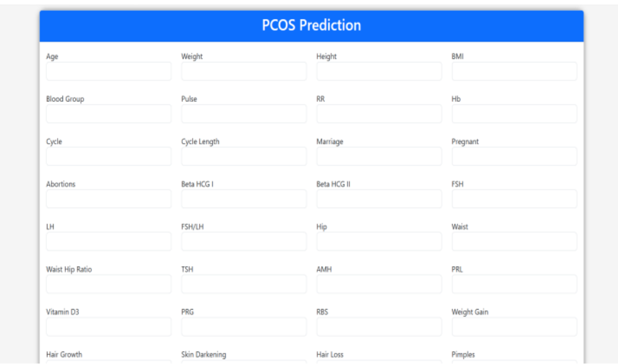

Fig 8 : Manual Prediction

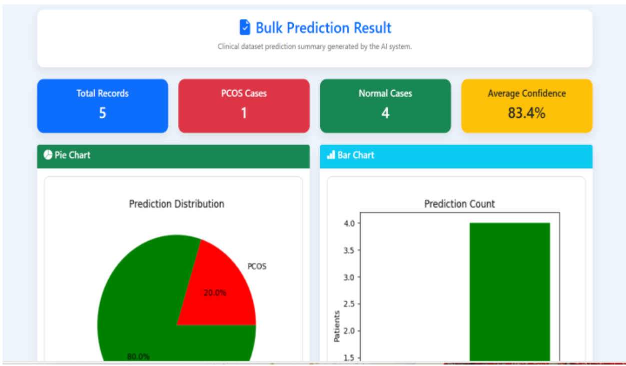

Fig 12 : Results Charts

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Fig 13 : Prediction Results

V. CONCLUSION

The proposed AI-Driven PCOS Detection System offers an innovative and effective approach for the early identification of Polycystic Ovary Syndrome (PCOS) by utilizing a combination of Machine Learning and Deep Learning techniques within a seamless web-based platform. This system integrates clinical parameter analysis with ovarian ultrasound image classification, providing a more precise and reliable diagnosis compared to methods that depend solely on one source of information. By assessing various machine learning algorithms and utilizing a Convolutional Neural Network (CNN) for image analysis, the framework successfully determines the most effective predictive models for PCOS detection. The application features distinct interfaces for both administrators and users. Administrators can manage datasets, train models, monitor overall performance, and oversee registered users, while users can make individual or bulk predictions, upload ultrasound images, track prediction history, and receive healthcare recommendations. Additionally, the system includes performance visualizations such as accuracy graphs, confusion matrices, training curves, and downloadable reports, enhancing the interpretability and user experience. Overall, this system provides a quick, accurate, secure, and user-friendly decision support platform for diagnosing PCOS. It minimizes manual effort, enhances diagnostic consistency, assists healthcare professionals in clinical decision-making, and promotes early disease detection. The integration of Artificial Intelligence with contemporary web technologies highlights the significant potential of intelligent healthcare systems in advancing women's reproductive health and improving computer-aided medical diagnosis.

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