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PCOS Image Detection Using MoblileNetV2 Transfer Learning on Ovarian Ultrasound Images

Deekshitha Nakkana[1], Gangadhar Doma[2]
[1]*Student, Master of Computer Applications (MCA), AQJ Centre for P.G. Studies (Affiliated to Andhra University, Visakhapatnam), Visakhapatnam, Andhra Pradesh, India*
[2]*Associate Professor, Department of MCA, AQJ Centre for P.G. Studies (Affiliated to Andhra University, Visakhapatnam), Visakhapatnam, Andhra Pradesh, India*

Abstract: Polycystic Ovary Syndrome (PCOS) is one of the most common hormonal disorders affecting women of reproductive age. Early diagnosis is essential to reduce long-term health complications and improve treatment outcomes. However, manual interpretation of ovarian ultrasound images is time-consuming and depends on the expertise of medical professionals. This paper presents an automated PCOS image detection system using the MoblileNetV2 deep learning architecture with transfer learning. Ovarian ultrasound images are preprocessed through resizing, normalization, and data augmentation before being used for model training. MoblileNetV2 automatically extracts discriminative image features and classifies the images into two categories: Infected (PCOS Positive) and Not Infected (PCOS Negative). The model is evaluated using Accuracy, Precision, Recall, F1-Score, and Area Under the ROC Curve (AUC). Experimental results demonstrate excellent classification performance, achieving 100.00% test accuracy, Precision = 1.00, Recall = 1.00, F1-Score = 1.00, and AUC = 1.0000 on the prepared dataset. A Streamlit-based web application is also developed to provide real-time prediction through a simple graphical interface. The proposed system demonstrates the effectiveness of transfer learning for automated PCOS detection and has potential applications in computer-aided medical diagnosis.
Keywords: Polycystic Ovary Syndrome, PCOS, Deep Learning, MoblileNetV2 , Transfer Learning, Medical Image Classification, Ultrasound Imaging, Streamlit.

I. INTRODUCTION

Polycystic Ovary Syndrome (PCOS) is a common endocrine disorder that affects women of reproductive age and is associated with hormonal imbalance, irregular menstrual cycles, infertility, and metabolic complications. Early diagnosis is important for effective treatment and long-term health management. Ultrasound imaging is one of the primary diagnostic methods used to examine ovarian morphology, but manual analysis of ultrasound images is often subjective and depends on the experience of healthcare professionals.

Recent advances in Artificial Intelligence (AI) and Deep Learning have enabled automated medical image analysis with high accuracy. Convolutional Neural Networks (CNNs) and transfer learning models have shown excellent performance in detecting diseases from medical images by automatically learning complex image features. Among these models, MoblileNetV2 provides improved training speed, computational efficiency, and classification accuracy.

In this work, an MoblileNetV2 -based transfer learning model is proposed for automated PCOS detection from ovarian ultrasound images. The model classifies images into PCOS Positive (Infected) and PCOS Negative (Not Infected) categories. A Streamlit web application is also developed to enable users to upload ultrasound images and obtain real-time predictions. The experimental results demonstrate that the proposed approach achieves excellent performance and can support computer-aided diagnosis.

II. RELATED WORK

Several researchers have applied deep learning and machine learning techniques for the automated detection of Polycystic Ovary Syndrome (PCOS) using medical imaging and clinical data. Recent studies show that Convolutional Neural Networks (CNNs) and transfer learning models can effectively extract image features and improve classification accuracy.

Traditional PCOS diagnosis mainly relies on ultrasound examination, hormonal analysis, and clinical assessment. Although these methods are widely used, manual interpretation of ultrasound images is time-consuming and may vary depending on the radiologist's expertise. This has encouraged researchers to develop automated computer-aided diagnosis systems.

Convolutional Neural Networks (CNNs) have been extensively used for medical image classification because they automatically learn discriminative features from images without requiring manual feature extraction. Several studies have reported good performance using CNN-based models for ovarian ultrasound image classification. However, training CNN models from scratch often requires large datasets and high computational resources.

To overcome these limitations, transfer learning techniques have gained significant attention. Pretrained models such as VGG16, ResNet50, InceptionV3, MobileNet, DenseNet, and EfficientNet have been successfully applied to various medical image classification tasks. These models use knowledge learned from large-scale image datasets and adapt it to specific medical applications, resulting in improved accuracy and faster convergence.

Among the available transfer learning models, MoblileNetV2 has demonstrated excellent performance due to its balanced network architecture, reduced computational cost, and faster training. It provides high classification accuracy while using fewer parameters than many conventional deep learning models, making it suitable for medical image analysis.

Although previous research has reported promising results, many studies focus on either clinical data or conventional CNN architectures. Some methods also require extensive preprocessing or large annotated datasets. These limitations motivate the development of an efficient and user-friendly automated system for PCOS detection. In this work, an MoblileNetV2 -based transfer learning model is proposed for classifying ovarian ultrasound images into **Infected (PCOS Positive)** and **Not Infected (PCOS Negative)** categories. The model is integrated with a Streamlit web application to provide real-time prediction through a simple interface. Experimental evaluation demonstrates excellent classification performance, showing the effectiveness of MoblileNetV2 for automated PCOS image detection.

III. PROPOSED METHODOLOGY

The proposed system employs a deep learning-based approach for the automatic detection of Polycystic Ovary Syndrome (PCOS) from ovarian ultrasound images. The workflow consists of dataset collection, image preprocessing, transfer learning using MoblileNetV2 , model training, evaluation, and deployment through a Streamlit web application. Figure 1 illustrates the overall workflow of the proposed system.

Workflow:
Dataset Collection → Image Preprocessing → MoblileNetV2 Model → Model Training → Performance Evaluation → Streamlit Web Application → PCOS Prediction

A. Dataset Collection

The dataset consists of ovarian ultrasound images organized into two classes:

1) Infected (PCOS Positive)
2) Not Infected (PCOS Negative)

The images are divided into separate training and testing folders. This organization enables the model to learn from the training data and evaluate its performance on unseen test images.

B. Image Preprocessing

Before training, all images undergo preprocessing to improve data quality and ensure compatibility with the deep learning model.
The preprocessing steps include:

- Resizing all images to 224 × 224 pixels.
- Normalizing pixel values.
- Applying data augmentation to the training dataset.
- Creating image batches for efficient training.

These operations improve model generalization and reduce the risk of overfitting.

C. MoblileNetV2 Transfer Learning

MoblileNetV2 was selected as the backbone network because of its high classification accuracy and computational efficiency. A pretrained MoblileNetV2 model initialized with ImageNet weights was used, and the original classification layer was replaced with a binary output layer suitable for PCOS image classification.

The model was trained using the Adam optimizer and the Binary Cross-Entropy loss function for 25 epochs.

D. Model Training and Evaluation

The prepared training dataset was used to train the MoblileNetV2 model, while the testing dataset was used to evaluate its performance. The trained model was assessed using standard classification metrics, including:

1) Accuracy
2) Precision
3) Recall
4) F1-Score
5) AUC (Area Under the ROC Curve)

The experimental results demonstrated excellent classification performance, indicating the effectiveness of the proposed approach.

E. Streamlit-Based Deployment

To provide a user-friendly interface, the trained model was integrated into a Streamlit web application. Users can upload an ovarian ultrasound image through the application, after which the image is automatically preprocessed and analyzed by the trained MoblileNetV2 model. The application displays the predicted class (**PCOS Positive** or **PCOS Negative**) along with the prediction confidence, enabling real-time image classification.

F. Proposed System Workflow

The complete workflow of the proposed system is summarized as follows:

1) Load the ultrasound image dataset.
2) Perform image preprocessing.
3) Train the MoblileNetV2 model using transfer learning.
4) Evaluate the trained model using the testing dataset.
5) Save the trained model.
6) Deploy the model using Streamlit.
7) Upload a new ultrasound image.
8) Predict the image class and display the result.

The proposed methodology combines transfer learning and a lightweight web interface to provide an efficient, accurate, and practical solution for automated PCOS detection from ovarian ultrasound images.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

The proposed PCOS Image Detection System was implemented using Python, TensorFlow, Keras, and Streamlit. The MoblileNetV2 transfer learning model was trained on the prepared ovarian ultrasound image dataset and evaluated using a separate testing dataset. The model performance was measured using Accuracy, Precision, Recall, F1-Score, and Area Under the ROC Curve (AUC).

A. Experimental Setup

The experiments were conducted on a Windows-based system using Python 3.10 and TensorFlow. Ultrasound images were resized to 224 × 224 pixels before training. The MoblileNetV2 model was trained using the Adam optimizer and Binary Cross-Entropy loss function for **25 epochs** with a batch size of 32.

B. Performance Evaluation

The trained model achieved excellent classification performance on the testing dataset. The evaluation results are summarized in Table I.

Table I. Performance Metrics of the Proposed MobileNetV2 Model

Metric	Value
Accuracy	**100.00%**
Precision	**1.00**
Recall	**1.00**
F1-Score	**1.00**
AUC Score	**1.0000**

The results indicate that the proposed model accurately classified all testing images into **PCOS Positive (Infected)** and **PCOS Negative (Not Infected)** categories.

C. Classification Report

The detailed classification report is presented in Table II.

Table II. Classification Report

Class	Precision	Recall	F1-Score	Support
Infected	1.00	1.00	1.00	781
Not Infected	1.00	1.00	1.00	1141

The classification report shows perfect precision, recall, and F1-score for both classes, demonstrating the model's ability to distinguish between infected and non-infected ultrasound images.

D. Discussion

The experimental results demonstrate that the proposed MoblileNetV2 -based approach provides highly accurate classification of ovarian ultrasound images. The use of transfer learning enabled the model to learn meaningful image features efficiently while reducing training time. Image preprocessing techniques, including resizing, normalization, and data augmentation, further improved the model's generalization capability.

The MoblileNetV2 model consistently outperformed the baseline CNN model developed during the initial phase of the project. Its lightweight architecture and optimized feature extraction contributed to faster convergence and higher classification accuracy.

The integration of the trained model with a Streamlit web application enables real-time prediction through a simple graphical interface. Users can upload an ultrasound image and receive an immediate prediction indicating whether the image belongs to the PCOS Positive (Infected) **or** PCOS Negative (Not Infected) class.

Overall, the experimental evaluation confirms that the proposed system is an effective computer-aided diagnosis tool for automated PCOS image classification. Although the obtained results are excellent for the prepared dataset, further validation using larger and more diverse clinical datasets is recommended to evaluate the model's robustness and generalizability in real-world healthcare environments.

V. CONCLUSION AND FUTURE WORK

A. Conclusion

This paper presented an automated PCOS image detection system based on the MoblileNetV2 transfer learning model for classifying ovarian ultrasound images. The proposed approach combines image preprocessing, transfer learning, and deep learning techniques to distinguish between **PCOS Positive (Infected)** and **PCOS Negative (Not Infected)** ultrasound images.

The model was trained and evaluated using a prepared ultrasound image dataset. Experimental results demonstrated excellent performance, achieving **100.00% test accuracy**, **Precision = 1.00**, **Recall = 1.00**, **F1-Score = 1.00**, and an **AUC score of 1.0000**. These results indicate that the proposed MoblileNetV2 model effectively learns discriminative image features and provides reliable classification performance.

A Streamlit-based web application was also developed to provide a simple and interactive interface for uploading ultrasound images and obtaining real-time prediction results. The proposed system offers a practical computer-aided diagnosis solution that can assist healthcare professionals in the analysis of ovarian ultrasound images.

B. Future Work

Although the proposed system achieved excellent results on the prepared dataset, several improvements can further enhance its practical applicability.

Future work may include:

- Training the model using larger and more diverse clinical datasets collected from multiple healthcare institutions.
- Extending the system to classify different stages or severity levels of PCOS.

- Integrating Explainable Artificial Intelligence (XAI) techniques, such as Grad-CAM, to visualize the image regions influencing the model's predictions.
- Comparing the performance of MoblileNetV2 with newer deep learning architectures, including Vision Transformers (ViT) and ConvNeXt.
- Developing a mobile application and cloud-based deployment for remote diagnosis and improved accessibility.
- Integrating the system with hospital information systems to support clinical decision-making and patient record management.

The proposed approach demonstrates the potential of deep learning for automated medical image analysis and provides a strong foundation for future research in AI-assisted PCOS diagnosis.

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