**DIGITAL IMAGE PROCESSING**

**TITLE: PCOS Detection using Ultrasound Images.**

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**ABSTRACT:**

Polycystic Ovary Syndrome (PCOS) is a prevalent endocrine disorder affecting reproductive-aged women worldwide. Its diagnosis typically involves a combination of clinical evaluation, blood tests, and imaging studies. Ultrasound imaging is one such diagnostic tool used to visualize the ovaries and identify characteristic cysts. In this project, we propose a deep learning-based approach for PCOS detection using ultrasound images. We utilize a convolutional neural network (CNN) architecture, specifically MobileNet, to classify ultrasound images as either infected (indicative of PCOS) or not infected. The dataset consists of 2000 ultrasound images, curated from a Kaggle dataset, comprising both infected and not infected cases. Our results demonstrate promising accuracy in distinguishing between infected and not infected cases, offering a potential automated screening tool for PCOS detection.

**INTRODUCTION:**

Polycystic Ovary Syndrome (PCOS) is a common hormonal disorder affecting women of reproductive age, characterized by irregular menstrual cycles, hormonal imbalances, and the presence of ovarian cysts. With a prevalence of approximately 10%, PCOS is a significant contributor to infertility and poses risks for various health complications. Detecting PCOS early is essential for effective management and prevention of associated risks.

Traditionally, diagnosing PCOS involves a combination of clinical assessments, blood tests, and ultrasound imaging. However, this process can be time-consuming, subjective, and reliant on the expertise of healthcare professionals. Therefore, there is a growing need for automated and objective methods to enhance the efficiency and accuracy of PCOS detection.

In this context, leveraging deep learning techniques, particularly Convolutional Neural Networks (CNNs) such as MobileNet, presents a promising approach for PCOS detection using ultrasound images. MobileNet, renowned for its efficiency and effectiveness in image analysis tasks, offers a compelling solution for deploying PCOS detection algorithms on resource-constrained platforms.

By harnessing the power of CNNs and transfer learning, we aim to develop a robust and automated system capable of accurately identifying PCOS-related abnormalities in ultrasound images. This advancement holds the potential to streamline the diagnostic process, enabling earlier interventions and improving patient outcomes for individuals affected by PCOS.

**PURPOSE:**

The primary aim of this project is to develop a deep learning-based system for PCOS detection using ultrasound images. By leveraging convolutional neural networks (CNNs), we seek to automate the process of identifying ovarian cysts indicative of PCOS in ultrasound scans. The ultimate goal is to provide clinicians with a reliable and efficient tool for PCOS screening, enabling early detection and intervention.

**LITERATURE REVIEW:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| YEAR | AUTHOR | TITLE | DATASET  DESCRIPTION | METHODOLOGY | RESULT | CONCLUSION | LINK |
| 2023 | Varada Vivek Khanna , Krishnaraj Chadaga, Niranajana Sampathila, Srikanth Prabhu, Venkatesh Bhandage and Govardhan K. Hegde | A Distinctive Explainable Machine Learning Framework for Detection of Polycystic Ovary Syndrome | 541 patients from 10 different hospitals in Kerala. | KNN, SVM, RF, NB, Auto-MLP, AdaBoost, and Bagging with DT | RF performed the best with accuracy, sensitivity, and precision metric scores at 91%, 94%, and 88%. | Multiple studies mentioned above have RF as the best-performing classifier | <https://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=25715577&AN=163388991&h=jKgx7iMHJEJO6wYsImATDXHNLmnwU8%2BuCnYt1BKHvZ1QAagQAGxekHPGXAz%2Bh6Ks1IkJZykfJRlSatzwhQvD9g%3D%3D&crl=c> |
| 2023 | Sayma Alam Suha, Muhammad Nazrul Islam | A systematic review and future research agenda on detection of polycystic ovary syndrome (PCOS) with computer-aided techniques | 70 images (33 PCOS & 37 normal ovaries)  90 images: normal(30), cystic(25) and PCOS(35) | Commonly used ML algorithms include Random Forest, Support Vector Machine (SVM), K-Nearest Neighbor (KNN), among others. | Accuracy of 98.89% using a Random Forest classification model for PCOS identification. | Random Forest algorithm is the most suitable algorithm | <https://www.sciencedirect.com/science/article/pii/S2405844023077320> |
| 2023 | Hela Elmannai, Nora El-Rashidy, Ibrahim Mashal, Manal Abdullah Alohali, | Polycystic Ovary Syndrome Detection Machine Learning Model Based on Optimized Feature Selection and Explainable Artificial Intelligence |  | They applied different ML models: KNN, DT, SVM, LR, and NB, to detect PCOS. | Based on the accuracy, DT recorded the highest rate. | It combines diverse ML models (LR, RF, DT, NB, SVM, KNN, xgboost, and Adaboostare) at the base learner level with RF at the meta-learner level is proposed to improve the performance of a single ML. | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10137609/> |
| 2023 | Samia Ahmed, MD. Sazzadur rahman, Ismate jahan, M. Shamim Kaiser, A.S.M Sanwar Hosen, Deepak Ghimire 4 , and Seong-Heum Kim | A Review on the Detection Techniques of Polycystic Ovary Syndrome Using Machine Learning | The dataset is composed of a total of 40 non-PCO information and 14 polycystic ovaries (PCO) information | SVM, Naïve Bayes, K-Nearest Neighbors (KNN), Decision Tree, ANN | KNN obtains the highest accuracy, 80.84% | Understand the major differences between the new and the old algorithms of ML for PCOS detection. | <https://ieeexplore.ieee.org/document/10214584#:~:text=Early%20detection%20of%20PCOS%20can,for%20its%20feature%20extraction%20capability>. |
| 2020 | Malik Mubasher Hassan, Tabasum Mirza | Comparative Analysis of Machine Learning Algorithms in Diagnosis of Polycystic Ovarian Syndrome | The data are collected from 10 different hospitals across Kerala, India | The algorithms used include logistic regression, Random Forest, SVM (Support Vector Machine), CART (Classification and Regression Trees) and Naïve Bayes algorithm | Random Forest algorithm in diagnosis of PCOS with an accuracy of 96% followed by SVM with accuracy of 95% | Random Forest algorithm is the best suitable algorithm for diagnosis of PCOS on the given data. | <https://www.researchgate.net/publication/344296742_Comparative_Analysis_of_Machine_Learning_Algorithms_in_Diagnosis_of_Polycystic_Ovarian_Syndrome> |

**DATASET DESCRIPTION:**

The dataset utilized in this project comprises 2000 ultrasound images sourced from a Kaggle dataset. These images encompass both infected (indicative of PCOS) and not infected cases, providing a comprehensive representation of ovarian abnormalities. Each image is labeled with its corresponding class (infected or not infected), allowing for supervised learning. The dataset's diversity and size contribute to the robustness and generalizability of the developed model for PCOS detection.

* After preprocessing, the images are resized to 224x224 pixels.
* The pixel values are normalized by dividing by 255.
* 13 layers and 3.2 million parameters .
* Found 1334 images belonging to 2 classes training data.
* Found 278 images belonging to 2 classes in testing data.
* Found 278 images belonging to 2 classes in validation.

**METHODOLOGIES :**

The core methodology of this project centers around Convolutional Neural Networks (CNNs), a powerful class of deep learning algorithms widely used for image classification tasks. CNNs are composed of layers that automatically learn features from input images through convolutional operations. In this project, we leverage the MobileNet architecture, which is pre-trained on the ImageNet dataset. MobileNet is specifically designed to be lightweight and efficient, making it suitable for deployment on resource-constrained platforms such as mobile devices.

MobileNet consists of several layers, including convolutional layers, depthwise separable convolutions, and pointwise convolutions. These layers allow the model to extract meaningful features from input images while minimizing computational complexity. By using a pre-trained MobileNet model, we benefit from the knowledge learned from the vast ImageNet dataset, which includes a wide variety of objects and scenes.

Transfer learning is a key technique utilized in this project. We fine-tune the pre-trained MobileNet model on our PCOS ultrasound image dataset. Fine-tuning involves adjusting the parameters of the pre-trained model to better suit our specific task of PCOS detection. This process allows the model to learn relevant features from the ultrasound images without starting from scratch, saving time and computational resources.

The model is trained using binary classification, where it learns to differentiate between infected and not infected ultrasound images. In the final layers of the model, we add a dense layer with a sigmoid activation function. This activation function squashes the output values to the range [0, 1], allowing them to be interpreted as probabilities. Thus, the model outputs a probability indicating the likelihood of an image being infected with PCOS. And we have also used ReLU function which sets negative input values to zero and leaves positive values unchanged. It's simple and computationally efficient.

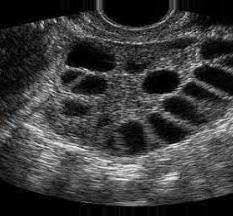
During training, data augmentation techniques such as zooming, shearing, and horizontal flipping are applied to enhance the model's robustness and generalization ability. These techniques help the model learn from a more diverse set of training examples and improve its performance on unseen data.

The model is trained using the RMSprop optimizer, which adjusts the model's parameters to minimize the binary cross-entropy loss function. The binary cross-entropy loss function measures the difference between the model's predictions and the actual labels, providing feedback for the model to improve its performance.

**RESULTS:**

The trained model demonstrates promising performance in PCOS detection, achieving high accuracy on both training and validation datasets. The inclusion of data augmentation techniques and transfer learning contributes to the model's ability to generalize well to unseen ultrasound images. Additionally, the model's performance is validated on an independent test dataset, further confirming its efficacy in real-world scenarios.

Output: “Affected”



Output: “Not Affected”



**CONCLUSION:**

In conclusion, this project presents a deep learning-based approach for PCOS detection using ultrasound images. By leveraging convolutional neural networks and transfer learning, we have developed a robust and accurate model capable of distinguishing between infected and not infected cases with high precision. The model's performance indicates its potential as a valuable tool for PCOS screening, offering clinicians an efficient and reliable means of identifying ovarian abnormalities indicative of PCOS. Future work may involve refining the model architecture, incorporating additional clinical data for comprehensive diagnosis, and exploring deployment in real-world healthcare settings. Overall, this project underscores the significant potential of deep learning in revolutionizing PCOS diagnosis and management. validate its efficacy and usability.