www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 12, No. 2.1, (2026), pp. 3163-3170
Open Access. Online & Print

DOI: 10.5281/zenodo.122.126244

POLYCYSTIC OVARY SYNDROME DETECTION USING ULTRASOUND IMAGE BASED ON DANDELION SIBERIAN TIGER OPTIMISATION ENABLED ENSEMBLE CLASSIFIERS

Trupti Deshmukh[1], Rakesh Verma[2*]

[1]*Computer Science and Engineering Sanjeev Agrawal Global Educational University, Bhopal, India*
tt11.deshmukh@gmail.com ORCID ID - 0009-0006-4882-6030
[2]*Computer Science and Engineering Sanjeev Agrawal Global Educational University, Bhopal, India*
rakesh.v@sageuniversity.edu.in ORCID ID - 0009-0006-9364-2126

Received: 11/12/2025
Accepted: 02/02/2026

Corresponding Author: Rakesh Verma (rakesh.v@sageuniversity.edu.in)

ABSTRACT

This study proposes an intelligent framework for Polycystic Ovary Syndrome (PCOS) detection using ultrasound images. An ensemble of deep learning models—ResNeSt, SA-Net, and DKN—optimized with Dandelion Siberian Tiger Optimization (DSTO) enhances diagnostic accuracy. Image preprocessing, DBSCAN-based segmentation, and feature extraction improve performance, achieving 96.32% accuracy and promising reliable, automated PCOS diagnosis in clinical applications.

KEYWORDS: Ultrasound Image Analysis, Deep Learning Ensemble Models, MATLAB, Medical Image Classification.

1. INTRODUCTION

Polycystic Ovary Syndrome (PCOS) is a complex endocrine condition, mostly experienced by women during their reproductive period, contributing significantly to infertility, hormonal imbalance, and metabolic complications. Among various diagnostic techniques, the use of ultrasound imaging continues to be an absolutely normal procedure in external manifestations of PCOS, specifically multiple cystic follicles.

The advent of machine learning and deep learning technologies in medical imaging has opened up new possibilities to strengthen the diagnostic accuracy, minimize subjectivity, and improve the results for patients. When it comes to PCOS diagnosis, the incorporation of artificial intelligence in form of AI techniques can be helpful in the early and regular detection of PCOS symptoms based on the ultrasound images. The current study also proposes a new deep learning model that incorporates ensemble classifiers such as ResNeSt, Shuffle Attention Network (SA-Net), and Deep Kronecker Network (DKN), and the Dandelion Siberian Tiger Optimization (DSTO). metaheuristic optimization algorithm is applied to optimize the classifiers. This leads to the goal of

creating an efficient method for the so identified characteristics of PCOS by using an automated system that overcomes limitations of current diagnostic procedures.

Hormonal imbalance, irregular monthly cycle and ovarian cyst make PCOS a very challenging health concern to women at reproducing age. The diagnosis of this endocrine disorder is subject to inconsistent subject interpretation of ultrasound imaging, resulting in a delay in treatment. To overcome these issues, the thesis develops an innovative framework for automating PCOS identification by combining the advantages of cutting-edge deep learning approaches with image processing. Combining an ensemble of classifiers, optimized by a special metaheuristic algorithm, this system shows promise in higher diagnostic accuracy and easier clinical workflow. Through removing human error and offering early diagnosis, the framework aims to improve patient outcome and facilitates PCOS diagnosis especially in resource constraint settings.

1.1. Problem Statement

Due to the polymorphic character and comparable symptoms to other endocrine and metabolic disorders, Polycystic Ovary Syndrome (PCOS) is complex to diagnose. While ultrasound is used for diagnosing PCOS, the analysis of the ultrasonic images is subjective which depends on the physician's opinion. Its use is driving gaps in casting diagnosis and generates time when expertise is scarce or imaging is inconclusive. The subjectivity in clinical practice means that certain cases are either underdiagnosed or misdiagnosed leading to effects on the treatment time-table and patient care [1]. The identification of ultrasounds through manual analysis of the images is a tiresome affair and may at times generate wrong results. Therefore, a high demand for a reliable and fast detection module that would be able to detect the PCOS characteristic patterns from the ultrasound images exists.

2. LITERATURE REVIEW

Polycystic Ovary Syndrome (PCOS), which is among the most common hormonal disorders, is frequently identified via ultrasound imaging. Nevertheless, ultrasound image analysis manually is vulnerable to subjectivity and may induce misdiagnosis or delaying treatment. As machine learning and deep learning skills advance, the diagnostic reliability enhances by filling in automated systems. Combining strength of different architectures to improve accuracy as well as overfitting is a popular method adopted in deep learning models especially in ensemble classifiers.

Density based clustering segmentation methods have been useful to segment ovarian follicles from noisy ultrasound background and thus provide a much better ROIs for features extraction. Further, statistical measures joined with texture-based methods have further improved the representation of PCOS specific patterns [2]. Here, we consider recent approaches that combine different architectures like ResNeSt, Shuffle Attention Networks, and Deep Kronecker Networks which lead to better sensitivity and specificity than using a single model. To run the model and optimize the model parameters, Optimization algorithms like DSTO (Dandelion Siberian Tiger Optimization) have been used to tune the model parameters thus improve the training speed as well as classification performance. These advancements suggest the power of deep learning frameworks (e.g., ensemble, optimization driven models) to advance objective, accurate, fast diagnostic tools for PCOS from ultrasound image.

2.1. Objectives

Developing a smart diagnosis framework for the identification of Polycystic Ovary Syndrome (PCOS) from ultrasonography tests is the main goal of this research. It attempts to reduce the impact of subjectivity in the classification using the deep learning and ensemble classification paradigms [3]. Namely, it relates to adequate signal acquisition of the ultrasonic images and the subsequent steps of filtering and enhancing the images, as well as the accurate segmentation of the polycystic follicles. Part of the objective also includes identifying features from these segmented regions followed by training of the ensemble classifiers which are ResNeSt, SA-Net, DKN using the DSTO algorithm to provide a better diagnosis.

3. PROPOSED METHODOLOGY OVERVIEW

The adoption of approach based on deep learning is the basis for the research study plan to detect PCOS from ultrasound images. The proposed methodology comprises of a deep learning-based ensemble method as an approach to apply PCOS detection on ultrasound image. The first operation carried out on the images is accomplished through the arithmetic mean filter that reduces the noise on the images and therefore the images are improved to enable further processing. Thereafter, the ovarian follicles are clustered by using the DBSCAN instead of the morphological characteristics for expanding the depiction of ROIs that may indicate PCOS development. These segmented images are then passed through feature extraction then involve the statistical measure mean variance, entropy and other higher order statistical features such as TLBP-DCT.

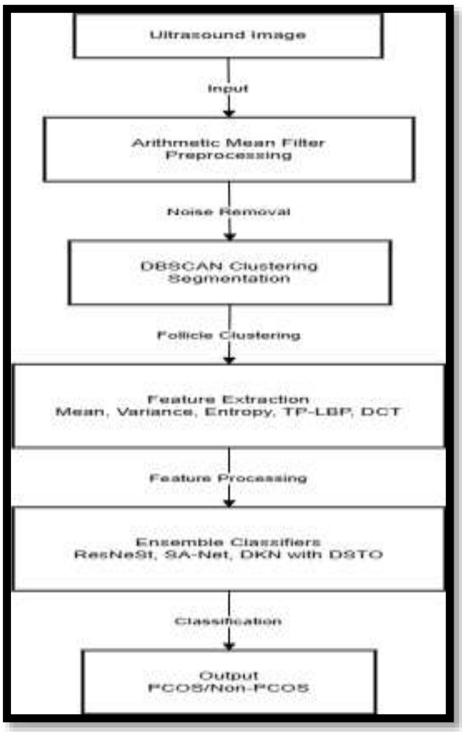

Fig.1: System Architecture Diagram (Source: draw.io).

The extracted features are passed to a hybrid ensemble classification model comprising ResNeSt, Shuffle Attention Network (SA-Net), and Deep Kronecker Network (DKN). For increasing learning ability of the classifiers, the technique of tuning parameters of the DSTO is utilized in order to locally search for the best position for the classifiers [4]. Evaluation of performance measures inlcuding accuracy, sensitivity, and specificity, help to establish how effective the constructed model is and these are examined in relation to the pre-existing assessment procedures. This is for the reason that the presented framework has been simulated in MATLAB and the intent behind it was to explain the process how the concept model can be used in the real-world situation.

3.1. Image Preprocessing

To begin the diagnostic process, the framework acquires noisy ultrasound images that are acquired with ultrasound technology that is inherently noisy. During preprocessing, the system uses an arithmetic mean filter to ensure high quality data for the analysis. Furthermore, this filter removes irrelevant noise and preserves the structural integrity of the ovarian features effectively. For computational efficiency, preprocessing is also designed so the system can be applied to large datasets, a requirement for practical clinical application. This phase improves image clarity, helping to provide a robust baselayer for subsequent analysis where the system performs upon clean and trusted data.

3.1.1. Segmentation of Ovarian Follicles

Following preprocessing, the framework partitions ovarian follicles in ultrasound images using the Density-Based Spatial Clustering of Applications with Noise (DBSCAN) algorithm. However, segmentation is critical, as regions of interest such as the number or size of follicles indicating PCOS are isolated. While traditional methods require pre-defined cluster counts, DBSCAN clusters follicles by their density and as a result of this, separates them out from surrounding tissues and noise. It provides a focused dataset of images segmented to highlight follicle distribution and character, essential to accurate diagnosis of follicular lymphoma. By reducing the complexity of downstream analysis, the system becomes more efficient.

3.1.2. Feature Extraction

Ovarian structures are characterized in terms of features extracted from a comprehensive feature extraction process applied to segmented images. A statistical based system that extracts mean, variance and entropy to describe intensity and texture variations. Moreover, it utilizes advanced texture-based features including Three Patch Local Binary Patterns (TP-LBP) and Discrete Cosine Transform (DCT) to present a detailed follicle pattern representation. With these features, it was possible to separate normal and polycystic ovaries with the potential of very high accuracy. The feature extraction process is robust to image quality of the patient demographic variation, guaranteeing its applicability across different populations.

3.1.3. Ensemble Classification

The heart of the framework is described as an ensemble classification module consisting of three deep learning classifiers. The techniques we use include ResNeSt, Shuffle Attention Network (SA-Net) and Deep Kronecker Network (DKN). Each of the classifiers brings its own strengths in the ensemble. Split attention mechanisms in ResNeSt improve feature representation, SA-Net boosts a set of relevant features by using attention mechanism, and DKN is able to capture complex spatial information of these images. Extracted features are passed to the classifiers in parallel, each classifier producing its own prediction independent of the others, the final diagnosis is a combination of all independent classifiers. By overcoming the limitation of the individual classifier such as overfitting by using an ensemble, we obtain a more accurate and reliable diagnostic system.

3.1.4. Optimization with DSTO

In addition, a novel metaheuristic algorithm Dandelion Siberian Tiger Optimization (DSTO) is introduced to help maximize the performance of the ensemble classifiers. This work incorporates the global search capability of Siberian Tiger Optimization (SiberianTi) into Dandelion Optimizer (DO) to create a more efficient and more capable technique. Each classifier’s performance is fine-tuned by DSTO by optimising its learning rates, convolutional filter sizes and dropout rates.

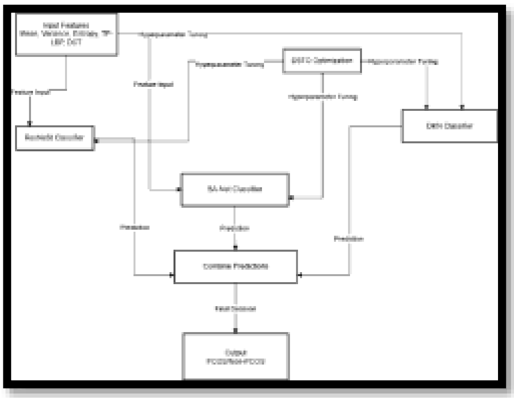

Fig.2: Ensemble Classifier Workflow (Source: draw.io).

More importantly, unlike previous work, this optimization process is designed to improve model training efficiency and classification accuracy while overcoming the computational burden typically associated with deep learning models. DSTO is a big innovation making the framework practical and effective.

4. DATASET DESCRIPTION AND PREPROCESSING

The data set to be utilized in the research consists of the following pictures and it is categorised into the two groups; Infected, which represents women with PCOS, and Not Infected, which represents the healthy women (PCOS- free) obtained from Kaggle. These images are divided in to the folders to be used for testing and training. The training set includes 200 images whilst the testing set is constituted with the 190 images. To reduce such interferences for each image, a series of preprocessing are carried out with the objective of making the images as best as possible in terms of quality and to eliminate noise that would complicate the subsequent analysis. Culturally, contrast and speckle noise make the ultrasound images to be blurred and noisy and therefore applying the arithmetic mean filter smooths the image appropriately while preserving the structures.

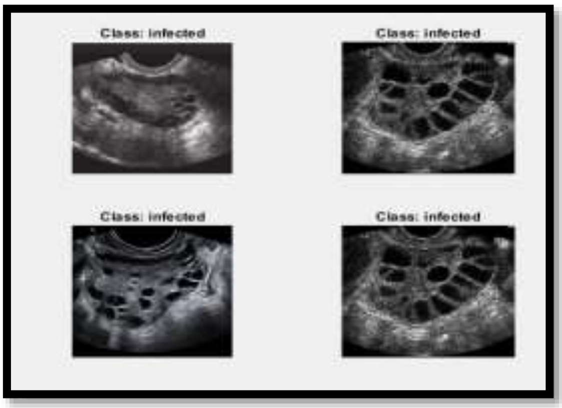

Fig 3: Dataset Overview.

This makes the next steps that involve segmentation and classification to be done on data that is highly preprocessed and with better format [5]. MATLAB is highly equipped with the function of image loading, image visualization and batch processing of images, thereby making the system capable of processing large quantities of data. This reprocessing's pipeline allows for a clear procedure in the identification of features as well as making the correct classifications to enhance the efficiency of the system.

4.1. Platform and Dataset

In addition, the framework is implemented in MATLAB, effectively a particularly flexible programming language, which can therefore be used for image processing and other machine learning. MATLAB provides robust libraries for image processing of ultrasound images from preprocessing till classification stages, as well as visualization tools that allow for a detailed performance analysis. A dataset including ultrasound images separated as positive and negative (PCOS affected vs healthy) cases is processed by the system, using separate training and test datasets. Classifiers are developed from the training set and the diagnostic accuracy is evaluated from the testing set. The rigorous validation of this structured approach paves a solid approach to clinical deployment.

4.1.1. Workflow Execution

The implementation of this approach is streamlined as described by loading and preprocessing of the images, segmentation, features extraction and classification. The system is designed as a modular system so that each piece of the system is seamless to integrate with the next piece to allow for data flow. By using MATLAB, batch processing of images is possible, allowing the framework to work on large data sets without noticeable delays. Besides implementation process, we monitor system performance through metrics such as accuracy and training time. This highlights the framework's capability for real world application with this careful execution.

4.2. IMAGE SEGMENTATION & FEATURE EXTRACTION

In corrosion detection of PCOS, segmentation and feature extraction involve the use of segmentation techniques to extract the region of interest from the ultrasound images and extracting those features exclusive to the disorder. The segmentation process is accomplished using the Density-Based Spatial Clustering of Applications with Noise (DBSCAN) algorithm for the identification of Ovarian Follicles, which are set from the other tissues [6]. Whereas other methods aim at thresholding of the pixels involved, DBSCAN has the capacity to cluster the same pixels basing on their density making it good when there is the noise in the picture.

4.2.1. Diagnostic Accuracy

The framework's performance in discriminating PCOS using ultrasound images are formidably promising. Such system projects an overall accuracy of 96.32 indicating to correctly diagnose PCOS as well as non-PCOS cases. Preliminary tests yield a sensitivity of 93.20%, thus, able to identify true PCOS cases, and can be allowed 100% specificity, hence ensure no false positives among normal samples [10]. With a F1 score of 0.96, the approach is balanced between precision and recall. The superior performance of the framework is reinforced via these metrics, which demonstrate significant improvements over traditional diagnostic methods, which are generally plagued with subjectivity and variability.

4.2.2. Clinical Implications

Moreover, the framework has high accuracy and reliability, with crucial implications for clinical practice. The system automates PCOS detection, eliminating dependency on skilled radiologists and could be very useful in regions with a shortage of such expertise. The framework's early detection allows for prompt intervention to avoid the long-term complications of infertility and metabolic disorder. In addition, the system can be achieved in busy clinic setting this is because its faster diagnosis is needed to facilitate proper patient management[2].

The proceeding with the classification, in order to obtain influential features, feature extraction is performed. Some of the features obtained are statistical measures of objects contained in the subject image such as mean, variance and entropy values; while the others are based on the concept of Three-Patch Local Binary Patterns (TP-LBP) and Discrete Cosine Transform (DCT). These features incorporate spatial and frequency differences in the ultrasound images and can give a better description of the characteristic of PCOS.

4.3. Ensemble Classification And Dsto Overview

The classification stage of the proposed system, ResNeSt, Shuffle Attention Network (SA-Net), Deep Kronecker Network (DKN) were combined in an ensemble learning manner. Ensemble learning is effective in the classification process as it uses the best classifiers, minimizes the generalization error, and increases the robustness of the classifier among deep learning classifiers.

```
DSTO Trial 1/5
Training trial network with parameters:
              filters1: 20
              filters2: 9
              filters3: 21
       combinedFilters: 35
           dropoutRate: 0.3923
          learningRate: 0.0079
           kernelSize1: 5
           kernelSize2: 5
           kernelSize3: 5
```

Fig 4: DSTO Trials.

Every individual model works involved in the classification process: ResNeSt offers a better capability of grouped convolution; SA-Net helps to amplify the gain of value in features; and DKN focuses on spatial relationships in the ultrasound images.

Fig 5: Model Accuray and Loss Curves

The performance of the ensemble classifier, the Dandelion Siberian Tiger Optimization (DSTO) approach is used [7]. DSTO is a two-tier metaheuristic algorithm based on both local search approach from Dandelion Optimizer and global search approach from Siberian Tiger Optimization algorithm (STO). Algorithm 1 shows the overall training process of DSTO in which hyperparameters like the number of convolutional filters, learning rate, dropout rates, and kernel size can be fine-tuned to achieve deep learning model accuracy. That is why the results of optimization showed the increase in model's training accuracy up to 100%, that means that the proper feature learning was achieved.

4.4. Results

A set of 190 ultrasound pictures were used to assess the efficacy of the suggested PCOS diagnostic framework.

```
Results:
Accuracy: 96.32%
Sensitivity (TPR): 93.20%
Specificity (TNR): 100.00%
Precision: 100.00%
F1 Score: 0.96
```

Fig 6: Final Result of the Model

Remarkably, the last model obtained an accuracy of 96.32%, which indicated its efficiency in identifying images with the affected women and distinguishing them from the healthy ones. The success of the suggested approach was also assessed using additional evaluation metrics including accuracy, F1-measure, True Positive Rate (TPR), and True Negative Rate (TNR). Regarding the internal validation of the model, the sensitivity achieved 93.20% therefore the model gives high ability to classify the of right cases of PCOS, the specificity achieved 100% therefore no false positive from the non PCOS cases.

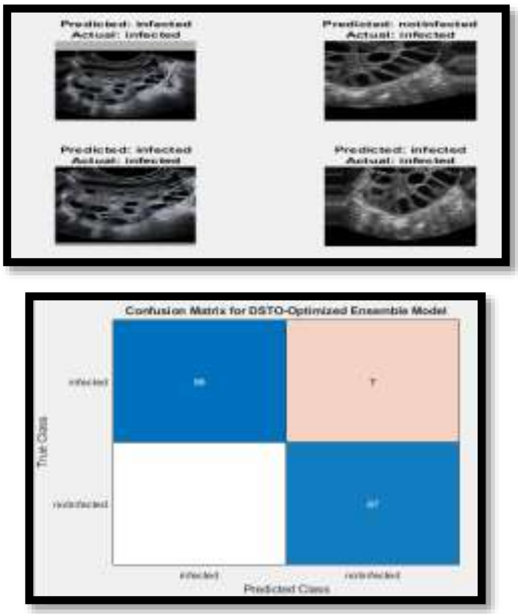

Fig 7: Model Prediction and Confusion Matrix

It also brings out the idea that all the PCOS cases forecasted were indeed accurate, thus no false alarm implications in clinical practice are possible [8]. Additionally, the F-scores of 0.96 indicate that the identified model, which is utilized in actual medical diagnosis, has an excellent balance between precision and recall capacity.

4.4.1. Addressing Diagnostic Challenges

The framework can tackle many of the challenges that confront present day PCOS diagnosis. When the data is noisy ultrasound images, or even when the interpretation of images is subjective, the conventional methods yield inconsistent results [9]. To overcome these issues, an advanced preprocessing, segmentation and classification system is proposed, to ensure reliable and objective diagnostics are possible. In addition, by handling complex datasets and accommodating various patient populations, it is further useful, establishing a new benchmark of PCOS detection.

4.4.2. Scalability and Accessibility

Through an automated approach, the framework scales, and can be deployed in urban hospitals or rural clinics. When you don't need to rely on human intervention; it produces low costs, and even the training requirements are reduced, therefore accessible. Both system's efficiency in processing large datasets results in it being able to meet high volume clinical environments and a non-negligible versatile tool for improving women's health globally.

5. CONCLUSION AND FUTURE WORK

The ultrasound based PCOS diagnosis framework proposed in the present work proves how deep learning and ensemble classification approaches may be integrated to improve diagnosis accuracy and reliability. The model is run with the aid of advanced architectures for example ResNeSt, Shuffle Attention Network (SA-Net) and Deep Kronecker Network (DKN), and performing well in terms of sensitivity, specificity, and overall diagnostic accuracy. Analysis on a carefully curated ultrasound image dataset was conducted with extensive experiments and the framework reduces the rate of misclassification while maintaining good performance over diagnostic outcomes.

The system could be extended by expanding with larger and more diverse datasets to broadly generalize models to different populations and imaging devices. Furthermore, XAI techniques can be integrated to improve the explainability and interpretability of the diagnostic predictions for clinical practitioners. Real time implementation of the model in clinical settings could also become future research and assess the effect on diagnosis time and patient management. The performance and stability of the model can be further improved by hybridizing DSTO with other soft computing techniques. Multi modal approaches combining ultrasound with clinical data and hormone profiles could finally provide a more comprehensive and robust framework for PCOS diagnosis though.

5.1. Dataset Expansion

However, the dataset could be expanded to include images acquired under other populations and from other imaging devices [11] in future development of the framework. In addition, this would make the system more robust and generalizable, so that the same performance is achieved across clinical scenarios. Additionally, with a larger, more varied dataset, the effectiveness of framework in real world settings can be validated.

5.2. Multimodal Integration

The diagnostic accuracy could be improved further by integrating additional data sources (e.g. clinical and hormonal profiles). Providing a more complete assessment of PCOS might be achieved by a multimodal approach, which would use imaging data tied to biochemical markers. These improvements will improve the diagnostic capability of this framework, converting it from the current theoretic hypothesis to a more comprehensive clinical tool.

REFERENCES

.Suha, S.A. and Islam, M.N., 2022. An extended machine learning technique for polycystic ovary syndrome detection using ovary ultrasound image. Scientific Reports, 12(1), p.17123.

A. Agrawal, R. Ambad, R. Lahoti, P. Muley, and P. S. Pande, "Role of Artificial Intelligence in PCOS Detection," Journal of Datta Meghe Institute of Medical Sciences University, vol. 17, no. 2, p. 491, Apr. 2022, doi: https://doi.org/10.4103/jdmimsu.jdmimsu_278_22.

Available at: https://link.springer.com/article/10.1007/s12652-020-02616-5

Available at: https://www.nature.com/articles/s41598-022-21724-0

Available at: https://www.sciencedirect.com/science/article/pii/S095219762200366X

Available at: https://www.sciencedirect.com/science/article/pii/S095219762200383X

B Poorani and Rashmita Khilar, "Classification of PCOS Using Machine Learning Algorithms Based on

Ultrasound Images of Ovaries," Apr. 2023, doi: https://doi.org/10.1109/iconstem56934.2023.10142359.

B. Wang et al., "Automatic creation of annotations for chest radiographs based on the positional information extracted from radiographic image reports," Computer Methods and Programs in Biomedicine, vol. 209, pp. 106331–106331, Aug. 2021, doi: https://doi.org/10.1016/j.cmpb.2021.106331.

Bavarsad, R., Niknam, S. and Ghasemi, M., 2022. Siberian Tiger Optimization: A new bio-inspired metaheuristic algorithm for solving engineering optimization problems. Engineering Applications of Artificial Intelligence, 114, p.105092.

J. Fan, J. Liu, Q. Chen, W. Wang, and Y. Wu, "Accurate Ovarian Cyst Classification With a Lightweight Deep Learning Model for Ultrasound Images," IEEE Access, vol. 11, pp. 110681–110691, Jan. 2023, doi: https://doi.org/10.1109/access.2023.3321408.

Kumar, A., Tripathi, S. and Jaiswal, A., 2021. A hybrid ensemble model for the diagnosis of polycystic ovary syndrome using machine learning techniques. Journal of Ambient Intelligence and Humanized Computing, 12, pp.10073–10087.

L. R. Lamb, C. D. Lehman, S. Do, K. Kim, S. Langarica, and M. Bahl, "Artificial Intelligence (AI)-Based Computer-Assisted Detection and Diagnosis for Mammography: An Evidence-Based Review of Food and Drug Administration (FDA)-Cleared Tools for Screening Digital Breast Tomosynthesis (DBT)," AI in Precision Oncology, vol. 1, no. 4, pp. 195–206, Aug. 2024, doi: https://doi.org/10.1089/aipo.2024.0022.

W. Lv et al., "Deep Learning Algorithm for Automated Detection of Polycystic Ovary Syndrome Using Scleral Images," Frontiers in Endocrinology, vol. 12, p. 789878, Jan. 2022, doi: https://doi.org/10.3389/fendo.2021.789878.

Y. Chen, D. Li, X. Zhang, J. Jin, and Y. Shen, "Computer aided diagnosis of thyroid nodules based on the devised small-datasets multi-view ensemble learning," Medical Image Analysis, vol. 67, p. 101819, Jan. 2021, doi: https://doi.org/10.1016/j.media.2020.101819.

Yuta Nambu et al., "A screening assistance system for cervical cytology of squamous cell atypia based on a two-step combined CNN algorithm with label smoothing," Cancer Medicine, vol. 11, no. 2, pp. 520–529, Nov. 2021, doi: https://doi.org/10.1002/cam4.4460.

Zhao, S., Zhang, T., Ma, S. and Chen, M., 2022. Dandelion Optimizer: A nature-inspired metaheuristic algorithm for engineering applications. Engineering Applications of Artificial Intelligence, 114, p.105075.