

Wearable Sensors for Gynecological Health Monitoring with AI-Driven Approaches in Post-Hysterectomy Ovarian Function Assessment

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INTRODUCTION & AIM

Hysterectomy, the surgical removal of the uterus, often preserves the ovaries but can disrupt their function due to reduced blood flow and hormonal imbalance. This may hasten the onset of menopausal symptoms related to cardiovascular, metabolic, and emotional health. Traditional follow-up methods such as ultrasound imaging and hormonal are limited and offer only episodic insights. Recent advances in wearable technology have enabled the continuous monitoring of physiological parameters which when analyzed with the use of artificial intelligence models, can be used to study changes over time. This study proposes a multi-modal AI-driven system for the assessment of ovarian function post-hysterectomy.

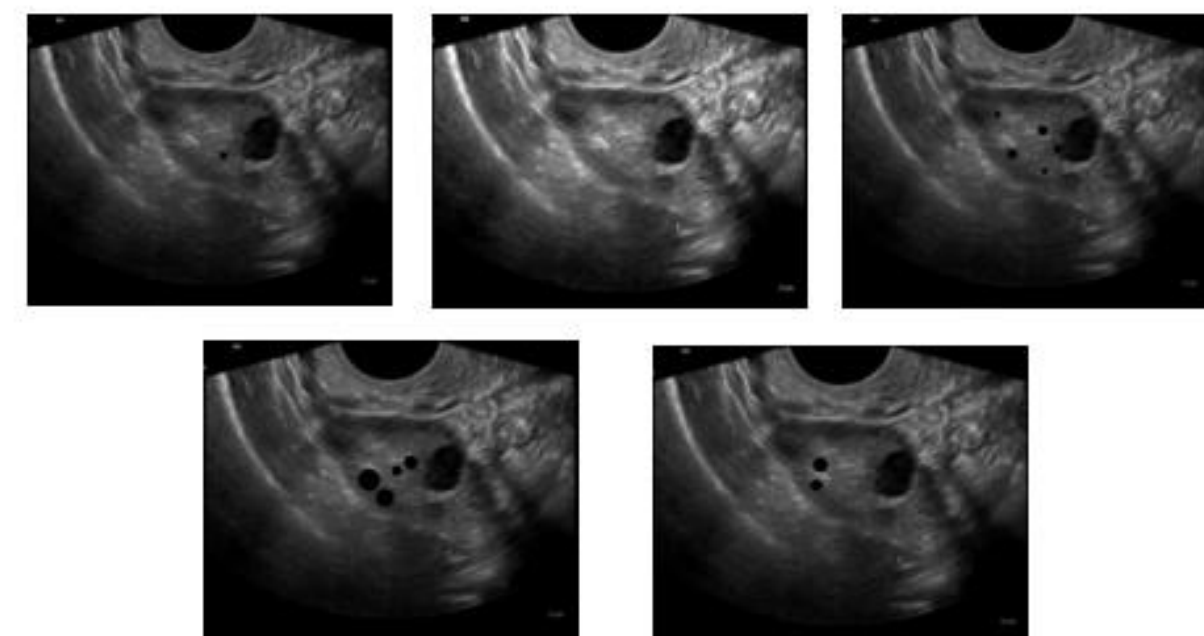
METHOD

This paper proposes the DFG-Net, an AI-based framework that helps in the assessment of ovarian function using two data modalities: wearable sensor data and ultrasound imaging. The synthetic datasets were created to ensure clinical variability without violating data privacy. For ultrasound datasets, around 250 grayscale images were used, classifying ovarian functions into five categories, namely active, declining, inactive, perimenopausal, and anomalous, comprising approximately 50 images each. Each image in the dataset was generated with controlled variation in the number, shape, and echotexture of the follicles to represent physiological variation.

Class	Number of Follicles	Ovary Axes (Shape)	Notes/Additional Variation
Active	3–7	Normal (axes = (60, 40))	Multiple well-distributed follicles; regular shape and uniform spacing
Declining	1–2	Slightly smaller (axes = (50, 35))	Follicles placed near edge or irregularly spaced; less dense
Inactive /Failed	0	Shrunken (axes = (40, 30))	No follicles; image may have increased echogenicity or texture grain
Perimenopausal or distorted)	1 (irregular)	Irregular (axes = (45, 25), rotated)	Off-centre, larger follicle with asymmetry; some noise variation
Anomalous	8–15	Normal or large (axes = (60, 40) or (65, 45))	Many small follicles, overlapping or clustered; may be unnaturally shaped or oddly distributed

For wearable data, the synthesized dataset consisted of 30-day time-series data representing 250 patients. The physiological parameters included heart rate, heart rate variability, galvanic skin response, basal body temperature, skin temperature, SpO₂, blood pressure, sleep quality, estradiol level, and progesterone level. These signals capture cyclical and hormonal fluctuations indicative of ovarian function.

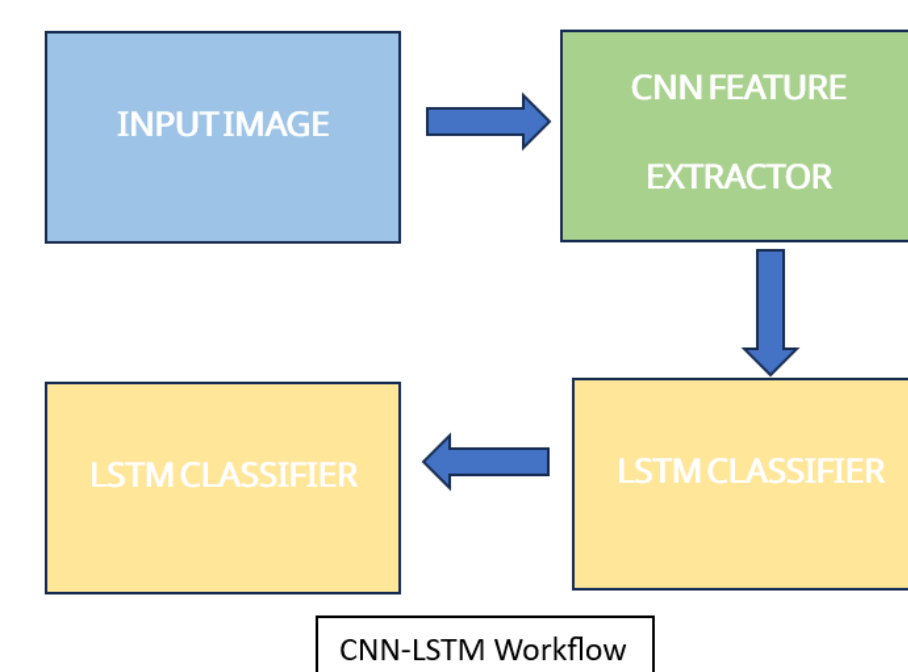
Ultrasound for each ovarian function category (active, inactive, declining, perimenopausal, anomalous).



The pipeline combines CNN processes ultrasound images of size 256×256, learning the spatial features relevant to ovarian morphology along with an LSTM network which examines wearable sensor time-series data to identify temporal dependencies across days. Features from both models are as one representation in DFG-Net and followed by dense layers and softmax classifier to classify ovarian function. The development of the model uses TensorFlow and OpenCV libraries to guarantee efficiency of processing and result interpretability.

RESULTS & DISCUSSION

With the synthetic dataset, the CNN yielded distinct separation of the five ovarian function classes. Sample outputs for classification had high probability values; for example, above 99% for the class 'declining' in test cases. The LSTM model effectively captured subtle trends in the variation of wearable data, such as flattened physiological rhythms corresponding to reduced ovarian activity. At the same time, when combined within DFG-Net, the combined model was able to demonstrate increased stability and robustness of classification compared to either modality in isolation.



This furthermore provides opportunities in remote health applications, such as post-operative management and long-term hormonal control.

CONCLUSION

The study presents DFG-Net, an AI model fusing wearable and ultrasound data for post-hysterectomy ovarian monitoring. It shows promising synthetic results, with future work aimed at clinical validation and expanding biosensor integration for secure, continuous health assessment.

FUTURE WORK / REFERENCES

Future work will focus on clinical validation, real-data integration, and expanding biosensor inputs for enhanced ovarian health monitoring