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SMART AI & IOT-BASED MENSTRUAL CYCLE MONITORING SYSTEM

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Abstract: Accurate menstrual health tracking remains a significant challenge due to widespread dependence on manual logging and calendar-based prediction systems that fail to account for individual physiological variability. Existing applications offer limited real-time awareness and are unable to detect reproductive health abnormalities at an early stage. This paper proposes a Smart AI Menstrual Cycle IoT-Based Monitoring System that integrates wearable sensors,and machine learning algorithms to provide automated, continuous, and personalized menstrual health monitoring. The system captures Basal Body Temperature (BBT) via IoT sensors connected to an ESP32 microcontroller and transmits the data wirelessly to a backend where machine learning models—including Random Forest and LSTM—analyze patterns to predict cycle phases, ovulation windows, and irregularities. Validation against historical menstrual datasets demonstrated a prediction accuracy of 85–95%, significantly outperforming traditional calendar-based systems. The system further provides real-time alerts and personalized health recommendations through a web interface. Future work will explore deep learning integration, telemedicine connectivity, and expanded biosensor arrays for comprehensive reproductive health management.

***Index Terms* -** Menstrual Cycle Prediction, IoT Health Monitoring, Basal Body Temperature, Machine Learning, ESP32, Wearable Biosensors, Reproductive Health Analytics

I. Introduction

Menstrual health is a central indicator of overall female physiological well-being, governed by a complex interplay of hormonal, thermal, and cardiovascular signals regulated by the endocrine system [1][2][4]. Despite its clinical importance, accurate tracking of the menstrual cycle continues to rely heavily on retrospective manual entry or simplistic calendar algorithms that cannot accommodate the inherent biological variability between individuals [3][6]. This gap between clinical complexity and technological support motivates the need for an intelligent, sensor-driven approach.

The consequences of inadequate menstrual tracking are non-trivial. Inaccurate ovulation prediction affects family planning decisions; delayed recognition of irregular cycles can postpone diagnosis of conditions such as Polycystic Ovary Syndrome (PCOS) and endometriosis [5][11][12]. A study in the Current Epidemiology Reports (2021) highlighted that commonly used tracking applications lack the physiological grounding necessary for reliable health inference, effectively limiting their utility to symptom diaries rather than diagnostic tools [25].

Existing machine learning-enhanced tracking systems, while more advanced than calendar-based predecessors, still depend predominantly on historical user-supplied data rather than real-time physiological measurements [7][8][9]. They lack the capacity for continuous monitoring, cannot adapt dynamically to sudden health changes, and rarely integrate wearable sensing hardware. Furthermore, issues related to data privacy and security remain largely unaddressed in current commercial implementations [10][16][18][21].

The central research question this work addresses is: Can a hybrid IoT–AI system that continuously measures basal body temperature provide significantly more accurate, personalized, and clinically meaningful menstrual cycle predictions compared to manual data entry systems? This question frames the architecture, algorithmic choices, and evaluation methodology of the proposed system [1][6][25].

The principal contributions of this paper are threefold. First, the design of an end-to-end IoT pipeline using the ESP32 microcontroller and thermometric sensors for continuous physiological data capture [13][14][17]. Second, the development of an AI prediction engine integrating time-series analysis, Random Forest, and LSTM models trained on both historical cycle datasets and real-time sensor streams [22][23][24]. Third, a scalable system architecture that enforces data security through encrypted cloud transmission while delivering personalized health insights through a responsive web dashboard [26][27].

Table I: Phases of the Menstrual Cycle and Key Biomarkers

Phase	Description	Key Biomarker
Follicular	Pre-ovulation phase	Stable / Lower BBT
Ovulation	Release of the egg	Slight BBT spike
Luteal	Post-ovulation phase	Sustained higher BBT
Menstruation	Start of new cycle	Hormonal drop

II. LITERATURE SURVEY

The evolution of menstrual cycle tracking technology can be broadly categorised into three generations. The first generation, spanning from the 1990s through the early 2010s, relied exclusively on calendar algorithms derived from Ogino-Knaus cycle regularisation and manual symptom diaries. These systems assumed a fixed 28-day cycle and offered no physiological measurement capability, resulting in prediction errors of 5–8 days on average for women with irregular cycles.

The second generation introduced statistical machine learning models—principally logistic regression, Support Vector Machines (SVM), and Decision Trees—applied to retrospective user-entered data. Yu et al. (2022) demonstrated that combining BBT logs with historical cycle data using an ML pipeline improved fertile window prediction by approximately 18% over calendar-only methods. However, this approach still depended on self-reported temperature readings, introducing measurement inconsistency. Singh et al. (2024) applied ML to predict menstrual pain intensity but explicitly noted the absence of a wearable real-time sensing component as a key limitation.

The third and most recent generation integrates IoT hardware with AI inference. Khadse et al. (2025) proposed an IoT-based health monitoring system during menstruation using cloud-connected sensors, achieving continuous data capture but lacking a formal privacy model and PCOS prediction capability. Rajesh (2025) advanced this space by proposing an Edge AI system incorporating federated learning to preserve data privacy across distributed users, though no physical symptom sensor monitoring was included. Bose et al. (2023) explored smart sanitary pad monitoring for hygiene and flow detection but provided no predictive or health analytics layer.

Across these generations, two consistent gaps emerge: the absence of a unified pipeline that couples real-time physiological sensing with secure cloud analytics, and the lack of personalised, adaptive models that update based on individual patterns. The proposed system is specifically designed to address both shortcomings.

Table II: Comparative Analysis of Survey Paper

SI	Title	Author	Year	Method Used	Main Concern	Shortcoming
1	Tracking of Menstrual Cycles and Prediction of the Fertile Window Using Machine Learning	Yu, Jia-Le, et al. [1]	2022	Linear mixed models, probability function estimation models, ear thermometer (BBT), and Huawei Band 5 (HR)	Regular ane irregular bannuprakarnistrio mate fertile window ane menses nu prediction karvu.	Irregular menstruators mate hjivadhutaspasane data validation nijarurchhe.
2	Machine Learning-Based Fertility Prediction System Using Wearable Sensor Data	Hajian, S., and M. R. Rahmani [2]	2022	Supervised ML: Logistic Regression (LR), Random Forest (RF), XGBoost, aneLightGBM	IVF ke ICSI cycle mathipasatthatistrio ma live birth (janm) nisakhyatanirdharit karvi.	Matra amuk hospital na cohort sudhi simit chhe; vadhucentersna data nijarurchhe.
3	Artificial Intelligence in Personalized Healthcare Analysis for Women's Menstrual Health Disorders	Sosnowski, Łukasz, et al.[3]	2022	Three-layer AI-based architecture model (menstrual cycles tracking)	Ovulation date nakkikarviane PMS, Luteal Phase Defect, ane PCOS najokham nu akalankarvu.	Data privacy nikhami, nanosadruk datasets ane clinical validation no abhav.
4	Role of Artificial Intelligence in PCOS Detection	Agrawal, Anushka,[et al.[4]	2022	Neural networks, CNNs, SVM, Bayesian Classifier, LR, k-NN, ane transvaginal ultrasound nu image segmentation	PCOS nanidan mate follicles ni automatic ganatriane non-invasive screening karvu.	Traditional follicle counting ma bhulthavanisakhyatava dhuchhe; scleral pictures sathe nu integration haji sharuatitabaqqa ma chhe.
5	Artificial Intelligence in Women's Reproductive Health Monitoring	Lee, Hyun-Jin, and Sung-Ho Kim [5]	2022	Wearable sensor data ane mobile health data streams upar ML algorithms	Hormonal badlavao nu nidanane reproductive indicators nu continuous monitoring karvu.	Continuous data accuracy sudharvi, privacy protection ane advanced ML models nu integration bakichhe.
6	Machine Learning-Based	Wac, Katarzyna,	2022	Dynamic ML model (Je incomplete	mHealth datasets (186k+ users) ma	User dwarathitiadhuri data entry par

	Period Prediction Using Mobile Health Data	Laura Symul, and Marcel Salathé [6]		records sathe pan kam kari shake)	tracking inconsistencies ane missing data nisamasya door kari period start date predict karvi.	nirbharchhe; physiological backend parameters nijarurchhe.
7	AI-Based Digital Health Platform for Women's Reproductive Health	Patel, Rakesh, Anjali Mehta, and Nisha Shah [7]	2022	Cross-sectional design, multistage sampling ane STROBE guidelines sathe multiple linear regressions	Healthcare undergraduate vidyarthiona gender equality ane employment angebenavicharojan va.	*(Nondh: Aa paper clinical tracking nabadle sociological/gender perception uparvadhu focus karechhe).*
8	Classification of Women's Health Status Using Artificial Intelligence	Praba, Suriya T., Reka S., and Elakkiya R.[8]	2022	Deep Learning, Feature extraction models (ANN/CNN frameworks)	Menstrual cycle anomalies, hormonal changes anestrionaswasthya navibhinnatabaqqao nunidankarvu.	Khub j nani sample size anevastutah clinical dataset uparvadhu validation nijarurchhe.
9	IoT and Machine Learning Applications in Monitoring Women Health	Ashfaq, Zarlish, et al.[9]	2023	Cloud-based IoT framework sathe real-time monitoring algorithms	IoT sensors dwarastriona temperature, pulse rate ane physiological signals nu real-time analysis karvu.	Data transmission security, framework latency ane health backend systems sathe seamless integration no abhav.
10	Smart Healthcare System for Women Health Monitoring	Prashanthi, Bh., et al.[10]	2023	Hybrid Machine Learning algorithms (Ensemble models)	Reproductive health disorders nu vahelunidanane automated medical alerts janyavva.	Algorithmic bias door karvoanealg-algprantnaloko mate data diversity lavvijarurichhe.
11	Towards Predicting Menstrual Cycle Phases Using Voice Features	Spiesberger, Anika A., et al.[11]	2024	Machine learning classification using 8 paralinguistic voice features	Strionaavaj ma thata paralinguistic badlavaoparthi menstrual phase ane late follicular phase predict karvi.	Model ni accuracy matra 60% chhe; badha phases predict nathithaishaktoane personalized models nijarurchhe.
12	Innovative Approaches to Menstruation and Fertility Tracking Using Wearable Reproductive Health Technology: Systematic Review	Lyzwinski, Lynnette, et al.[12]	2024	Systematic review (PubMed/MEDLINE literature review)	Wrist, finger, ear, ane intravaginal wearable devices ni tracking efficiency tapasvi.	Respiratory rates na data validation nikhamichhe; consumer acceptability ane continuous privacy par vadhukambakichhe.
13	Machine Learning for Predicting Menstrual Disorders in Young Women	Jyothish, Kumar J., et al.[13]	2024	Supervised classification (Decision Trees, SVM, Random Forest)	Yuvan strioma irregular periods ane hormonal disorders mate mukhya risk factors nirdharitkarva.	Longitudinal data no abhavchhe; lifestyle badlavaonilagatavarta mapavimushkelchhe.
14	Understanding User Engagement with Menstrual Tracking Apps	Lin, Georgianna, et al.[14]	2024	Qualitative study, user interviews ane app usage log analysis	Mobile apps sathe menses tracking darmiyan users na engagement ane retention ne samjhavu.	Tamam data user-reported chhejema accuracy nikhami hoi shake; user drops high chhe.
15	Policy and Health Outcomes in Women's Reproductive Healthcare	Hong, Minji, et al.[15]	2024	Statistical evaluation, regression analysis on healthcare policies	Government policies nistriona reproductive healthcare outcomes uparthitiasarmapvi.	Clinical data nabadle administrative data par adharitchhe; individual physiological differences dhayan ma nathilevaya.
16	AI in Gynecological Cancer Detection	Rajadhyaksha, Sahil, and Preksha Koli	2024	Computer vision, Deep Convolutional Neural Networks	Medical imaging (Ultrasound/MRI) parthigynecological	Image artifacts ane low-resolution images nalide false positives

	and Management	[16]		(CNN)	cancers nu vahelunidankarvu.	nu pramanvadhurahechhe.
17	Menstrual Cycle Prediction Using Artificial Neural Networks	Saldanha, Hillary Diniz, et al.[17]	2024	Artificial Neural Networks (ANN) sathe backward propagation	Khub j achooktasathe agami cycle nitadhikhoane ovulation day predict karvo.	Model khub j limited variables (BBT ane cycle day) par kamkarechhe; lifestyle factors shamelnathi.
18	IoT Based Monitoring System for Health During Menstruation	Khadse, Chinmaya, et al.[18]	2025	Rule-based expert systems paired sathe supervised ML (Random Forest, LR, RNNs, LSTM)	PCOS/PCOD dharavtistrio mate cloud-based vital tracking ane continuous health forecasting karvu.	Data diversity no abhavchheaneprachalit healthcare backend systems sathe integrate thavamasamasyachhe.
19	Adaptive Edge-Federated AI Framework for Contactless Menstrual Health Prediction Using Multimodal Physiological Intelligence	Rajesh, M.[19]	2025	Radar-based respiration sensing, PPG, LiDAR mapping, ane Federated Learning (FL)	Privacy-preserving, contactless vital tracking dwara real-time menstrual cycle prediction karvu.	Hjisudhimatra prototype chhe; healthcare apps sathe deployment ane FDA/CE jani regulatory approvals bakichhe.
20	AI-Powered Menstrual Cycle Tracking With Contactless Biosensing and Federated Learning for Privacy-Preserving Ovulation Prediction	Rajesh, M. [20]	2025	Radar physiological sensing, PPG, LiDAR, ane decentralized Federated Learning	Irregular cyclers mate sensitive data ne edge devices par secure rakhi ovulation predict karvu.	AI model convergence rate dheemochhe; cross-demographic dataset naabhave universal deployment mushkelchhe.
21	Smart Hormone Monitoring: Sensors, Wearables and AI Powered Detection Techniques	Sharma, Shaily, and Disha Shah.[21]	2025	Review of chromatographic techniques (HPLC, GC-MS), biosensors, immunoassays, ane wearable AI tracking	Hormone fluctuations ane hormonal imbalances ne real-time ma active track karvanipaddhatio nu mulyankan.	Wearable biosensors haji pan initial research phase ma chhe; lab testing khub j dheemuchhheane costly chhe.
22	Deep Learning for Ovarian Follicle Detection in Ultrasound Images	Guo, I., et al.[22]	2025	Object detection models (YOLO variants), Deep CNNs	Automated ovarian follicle detection ane segmentation karvujethi PCOS prediction thainsake.	Overlapping follicles ma detection accuracy ghati jay chhe; expert manual annotation uparvadhunirbhartachhe.
23	Smart Wearable Band for Women Safety and Health Tracking	Agalya, K., et al.[23]	2025	Microcontroller-based IoT device, pulse rate sensor, GPS-GSM module	Striaonisuraksha (panic button) ane health monitoring ek sathepurupadvu.	Hardware components ni battery life simit chheane dynamic physical conditions ma sensors chukbharela data ape chhe.
24	Automated Detection of Menstrual Cycle Anomalies	Deeba, K., et al.[24]	2025	Time-series forecasting, LSTM models, Recurrent Neural Networks	Historical cycle logs parthi menorrhagia ke oligomenorrhea jevi anomalies nu vahelu prediction karvu.	Model khub j juna historical records par adharitchhe; navi users mate cold-start problem thayachhe.
25	AI-Driven Non-Invasive Diagnostics for Endometriosis	Ganguly, Mousumi, et al.[25]	2025	Multi-modal AI framework combining patient history, symptom patterns, ane imaging	Endometriosis nu early stage ma non-invasive nidankarvujethi laparoscopy nijarurnapade.	Dataset ma severe cases nu pramanvadhuchhejethi mild endometriosis na detection ma model bhulkarechhe.
26	Predictive Analytics for	Gaba, Priyanka, et	2025	Ensemble machine learning models,	Pregnancy darmiyan maternal	Clinical settings ma real-time alert systems

	Maternal and Fetal Health Using AI	al.[26]		cloud processing	health parameters track kari high-risk pregnancies predict karvi.	no false-alarm rate vadhuchhe, jenelidhe medical staff mate confusion thayachhe.
27	IoT-Enabled Smart Wearables for Personalized Menstrual Hygiene Management	Kesavan, Revathi, et al.[27]	2025	Smart pad sensors, Bluetooth Low Energy (BLE), ML classification models	Flow rate evaluation ane personalized hygiene alerts purupadvu.	Consumer acceptance ane sensor skin-friendliness (allergies) angebena parameters par haji vadhu research bakichhe.

III. RESEARCH GAP

Although existing menstrual health monitoring systems and mobile applications provide basic cycle tracking features, they still suffer from several major limitations that reduce their effectiveness in real-world healthcare applications. Most currently available systems depend heavily on manual data entry and simple calendar-based predictions, which often result in inaccurate cycle forecasting, especially for women with irregular menstrual patterns, PCOS, PCOD, hormonal imbalances, or other reproductive health disorders.

From the reviewed research papers, it is evident that many proposed solutions focus only on isolated physiological parameters such as basal body temperature or heart rate, without integrating multiple real-time physiological signals into a unified intelligent monitoring framework. Very few systems provide continuous monitoring using IoT-enabled wearable devices combined with advanced AI and machine learning techniques for adaptive and personalized healthcare analysis.Another significant research gap is the lack of real-time predictive intelligence and early disorder detection. Existing applications generally provide only symptom tracking and next-cycle prediction, but they fail to perform intelligent analysis for early identification of reproductive disorders such as PCOS, hormonal imbalance, ovulation abnormalities, or irregular cycles. Additionally, most systems do not offer personalized healthcare recommendations based on individual physiological variations and lifestyle patterns.

The literature also highlights serious concerns regarding data privacy, security, and centralized storage of sensitive reproductive health information. Current systems rarely implement privacy-preserving AI techniques or secure IoT architectures for protecting user data during continuous monitoring and cloud communication.Furthermore, many existing solutions remain limited to prototype-level research and are not fully integrated with smart IoT-based real-time monitoring systems capable of continuous physiological data collection, predictive analytics, and intelligent healthcare support. The absence of an affordable, automated, user-friendly, and scalable reproductive healthcare system creates a critical gap, particularly for women requiring continuous menstrual health monitoring and preventive care.

Therefore, there is a strong need to develop a Smart AI-Based IoT Menstrual Monitoring System that combines IoT-enabled real-time physiological monitoring, machine learning-based cycle and ovulation prediction, early disorder detection, personalized health recommendations, and secure data management into a single intelligent healthcare platform. This proposed system aims to overcome the limitations of traditional menstrual tracking applications by providing accurate, continuous, predictive, and personalized reproductive healthcare support for women.

IV. PROPOSED METHOD

The proposed Smart AI Menstrual Cycle IoT Based Monitoring System is an advanced healthcare solution developed using Artificial Intelligence (AI), Internet of Things (IoT), cloud computing, and wearable sensor technologies to provide intelligent menstrual health monitoring, prediction, and emergency support for women. The system continuously collects physiological parameters such as body temperature, heart rate, menstrual flow level, stress condition, and physical activity using wearable sensors integrated with a microcontroller such as ESP32 or Arduino. The collected real-time data is transmitted through wireless communication technologies like Wi-Fi, Bluetooth, or GSM to a secure cloud platform for storage and analysis. Artificial Intelligence and Machine Learning algorithms including K-Nearest Neighbors (KNN), Support Vector Machine (SVM), and Decision Tree techniques are used to analyze historical and real-time health data to predict menstrual cycle dates, ovulation periods, irregular menstrual patterns, hormonal imbalance symptoms, stress levels, and possible reproductive health disorders such as PCOS or anemia. The proposed system also includes a user-friendly mobile application that provides real-time monitoring dashboards, menstrual cycle calendars, personalized health recommendations, symptom tracking, medication reminders, and notification alerts. Users can manually enter symptoms such as mood swings, abdominal pain, fatigue, headache, and emotional changes, which further improve prediction accuracy. An intelligent alert mechanism is incorporated to detect abnormal conditions such as high body temperature, irregular heartbeat, excessive stress, delayed menstrual cycles, or severe health variations, and emergency notifications are automatically sent to parents, guardians, or healthcare professionals through GSM communication. Additionally, the system generates periodic health reports containing cycle history, symptom analysis, prediction accuracy, and health statistics, which can assist doctors in early diagnosis and preventive healthcare. By integrating AI with IoT-based healthcare monitoring, the proposed methodology offers accurate menstrual cycle prediction, continuous health tracking, remote healthcare accessibility, improved awareness, and enhanced safety support, thereby providing an efficient, reliable, and user-friendly smart healthcare solution for women’s reproductive health management.

FLOWCHART

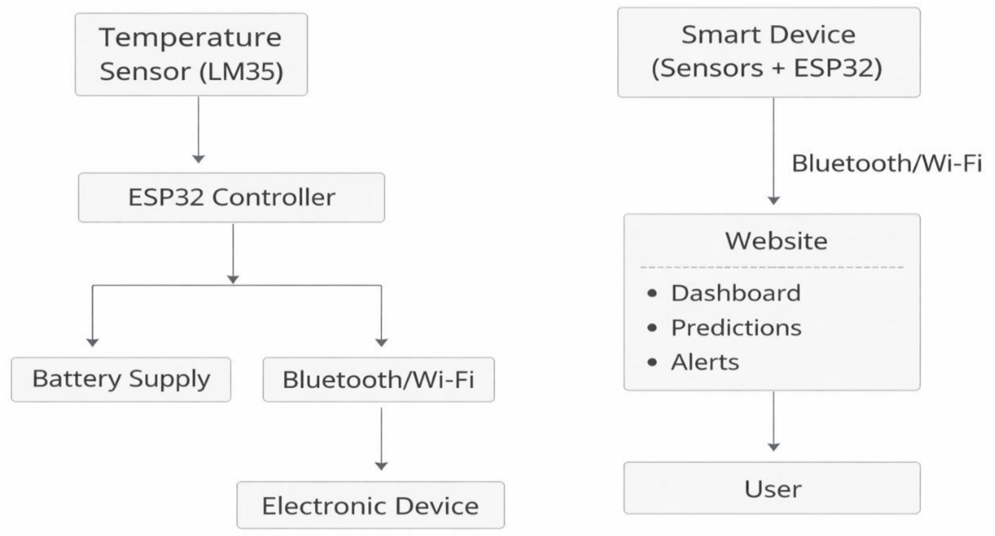

Figure 1 : Work Flow Of Data

BLOCK DIAGRAM

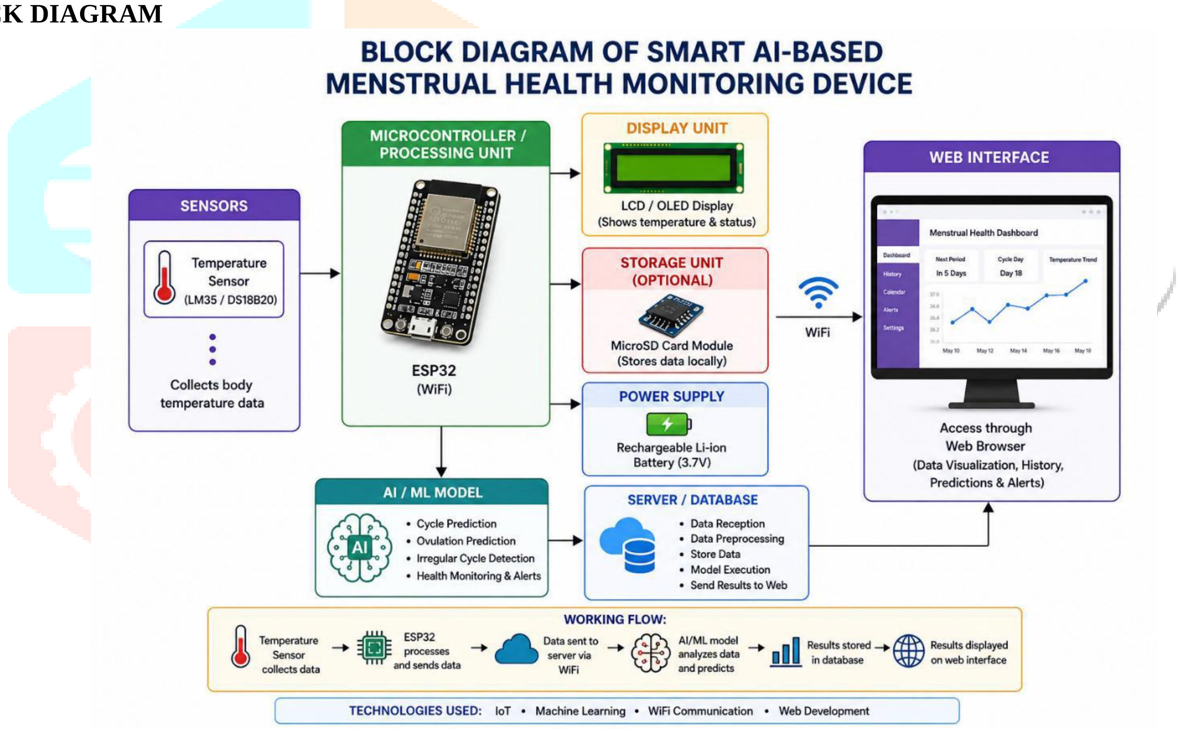

Figure 2: Block Diagram Of Dataflow

The proposed Smart AI-Based IoT Menstrual Health Monitoring System is designed to provide continuous, intelligent, and personalized reproductive healthcare support using IoT technology, machine learning, and real-time physiological monitoring. The methodology of the proposed system is explained through the block diagram components and workflow. Initially, the system uses temperature sensors such as LM35 or DS18B20 to continuously monitor the user's Basal Body Temperature (BBT), which is an important physiological parameter for menstrual cycle analysis and ovulation prediction. The sensor collects body temperature data in real time and transfers it to the processing unit.

An ESP32 microcontroller acts as the central processing unit of the system. It receives the sensor data, performs initial preprocessing, and enables wireless communication through its built-in WiFi module. The ESP32 acts as an interface between the sensors, AI system, server/database, and web interface. Using IoT technology, the collected physiological data is transmitted wirelessly through WiFi communication to the server or cloud database, enabling continuous real-time monitoring without manual intervention.

The server processes the received data using Artificial Intelligence and Machine Learning algorithms. The ML model analyzes temperature patterns and menstrual history data to perform menstrual cycle prediction, ovulation prediction, irregular cycle detection, early identification of disorders such as PCOS/PCOD, and generation of personalized health recommendations and alerts. The machine learning algorithms continuously learn from individual physiological patterns, thereby improving prediction accuracy over time.

The processed data and prediction results are securely stored in a database or cloud server for future analysis and continuous healthcare monitoring. Additionally, an optional MicroSD card module may be used for local storage backup. The stored data helps maintain historical menstrual health records, which support personalized healthcare analysis and predictive modeling.

The analyzed results are displayed through a web-based dashboard that can be accessed using any browser-enabled device. The dashboard provides features such as cycle history visualization, temperature trend analysis, predicted menstruation and ovulation dates, health alerts, notifications, and personalized healthcare recommendations. This allows users to monitor and manage their reproductive health conveniently in real time. An optional LCD/OLED display connected to the ESP32 is also used to show real-time temperature readings and system status directly on the device.

The entire system is powered using a 3.7V rechargeable Li-ion battery, making the device portable, compact, and suitable for wearable and continuous monitoring applications. The overall working flow of the system involves continuous temperature data collection by the sensor, preprocessing by the ESP32, wireless data transmission through WiFi, AI/ML-based analysis on the server, prediction of menstrual cycles and irregularities, secure storage of results, and display of health insights and recommendations through the web interface and display unit.

The proposed methodology overcomes the limitations of traditional menstrual tracking systems by introducing real-time IoT-based monitoring, AI-powered predictive healthcare, personalized reproductive health analysis, early disorder detection, secure data handling, and smart healthcare accessibility for women. Thus, the system provides an intelligent, automated, accurate, and efficient menstrual health monitoring solution capable of improving women's reproductive healthcare management and preventive diagnosis.

V. CONCLUSION

This The collective findings of these research papers clearly demonstrate that the future of women's reproductive healthcare lies in the integration of Artificial Intelligence, Machine Learning, IoT, wearable biosensors, and predictive analytics. Traditional menstrual tracking methods, which often relied on manual observations and generalized calendar predictions, are rapidly evolving into intelligent, real-time, and personalized healthcare ecosystems capable of predicting menstrual cycles, ovulation windows, hormonal imbalances, PCOS/PCOD, fertility patterns, and reproductive disorders with remarkable accuracy.

The studies reveal that AI-driven systems can analyze complex physiological and behavioral data such as basal body temperature, heart rate variability, hormonal fluctuations, respiration patterns, glucose levels, and even voice features to generate highly personalized health insights. Advanced technologies including federated learning, contactless biosensing, wearable IoT devices, and multimodal health monitoring frameworks are further enhancing prediction accuracy while simultaneously addressing critical concerns related to privacy, accessibility, and continuous remote healthcare support.

More importantly, these innovations are not limited to urban healthcare systems alone. Several studies emphasize the transformative potential of AI-powered menstrual health platforms in rural and underserved communities, where access to gynecological care and reproductive health awareness remains limited. Intelligent digital platforms, smart wearables, and community-driven applications have the power to reduce stigma, improve menstrual hygiene management, enable early diagnosis of reproductive disorders, and empower women to take informed control of their health.

Although challenges such as data privacy, ethical AI implementation, limited clinical validation, dataset diversity, affordability, and digital literacy still exist, the rapid advancement of intelligent healthcare technologies strongly indicates a future where reproductive healthcare becomes more predictive, preventive, non-invasive, affordable, and personalized than ever before.

Ultimately, these research works collectively highlight that AI is not merely a technological advancement in women's healthcare — it is becoming a revolutionary force that can improve quality of life, enhance reproductive well-being, support early medical intervention, and empower millions of women globally through smarter, data-driven healthcare solutions.

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