

# Smart AI PCOD/PCOS Detection System

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**Abstract:** Polycystic Ovary Syndrome (PCOS) and Polycystic Ovarian Disease (PCOD) are one of the most common hormonal disorders in women in the world. It causes irregular menstrual cycle, infertility, metabolic disorder, insulin resistance, obesity and psychological stress. Major challenges for early detection and continuous monitoring are still limited awareness, delayed diagnosis and unaffordable personalized healthcare systems. This paper presents a Smart AI PCOD/PCOS Detection System, a web-based health care platform that uses integrated AI and IoT to help in early symptom analysis, menstrual cycle tracking, lifestyle monitoring and real-time physiological parameter analysis. The system incorporates two levels of diagnostics. Level 1 provides AI-assisted analysis of the menstrual and hormonal symptoms via a responsive web application. The users perform medically relevant questionnaire-based assessments related to menstrual irregularities, PMS symptoms, weight fluctuations, acne, hirsutism, bloating, sleep irregularities, and ovulation abnormalities. The gathered data is processed using a Machine learning prediction pipeline with a Random Forest classifier trained on real PCOS datasets to predict the risk probability. The level 2 is IoT based physiological monitoring, which includes temperature sensors, heartbeat sensors, insulin detection module, microcontroller unit and LCD display system for acquiring real-time biological readings. The sensor data is transmitted wirelessly to a backend server based on Flask and synchronized to Firebase Real-time Database. The system is equipped with Responsive Dashboards, Live Analytics using Chart.js, Professional PDF Medical Report Generation using Report Lab, Notification Systems, Multi-Language Support, AI Chatbot Assistance and Wellness Recommendation modules for Diet, Yoga, Hydration and Sleep Tracking. The collected data is processed through a Machine Learning prediction pipeline where a Random Forest classifier trained on real PCOS datasets is used to predict the risk probability. The second level entails IoT-based biological monitoring with the use of temperature sensors, heartbeat sensors, insulin detector, microcontroller units, and LCD screen displays for gathering real-time information. The sensor data is relayed via wireless means to the server built on Flask architecture and then synchronized through Firebase

Real-time Database. There are also dashboards with live analytics based on Chart.js, professional PDF reports using Report Lab, notifications, multiple language support, AI chatbots, and health recommendation services such as dietary, yoga, hydration, and sleep management services. The mentioned platform will be evidence of the implementation of Artificial Intelligence, IoT, Machine Learning, web technology, and healthcare data analysis to create a menstruation health platform that will enhance the PCOD/PCOS early warning and healthcare monitoring system.

**Keywords:** PCOD, PCOS, Machine Learning, IoT, Flask, Firebase, Women's Healthcare, Menstrual Tracking, Random Forest, AI Healthcare System, Ovulation Prediction, Real-Time Monitoring., Polycystic Ovary Syndrome, Polycystic Ovarian Disease, Irregular Menstrual Cycle, Infertility, Integrated AI, IoT, Web Application, PMS Symptoms, Hirsutism, Random Forest Classifier, IoT Based Physiological Monitoring, Firebase Real-Time Database, Temperature Sensors, Heartbeat Sensors, Insulin Detector, Microcontroller Units, LCD Screen Displays

## I. INTRODUCTION

Disorders related to women's reproductive health are becoming increasingly relevant in today's world owing to factors such as changes in lifestyle habits, high levels of stress, poor dieting practices, obesity, hormone levels, and delay in seeking proper medical diagnosis. Some of these reproductive disorders include polycystic ovarian syndrome (PCOS) and polycystic ovarian disease (PCOD), which are among the most commonly diagnosed endocrine disorders among women of childbearing age. As per the latest research studies on global healthcare trends, approximately one out of ten women is suffering from PCOS symptoms.

PCOD/PCOS involves various bodily processes such as the menstrual cycle, ovulation cycles, insulin resistance, metabolism, fertility, psychological well-

being, and cardiovascular physiology. Symptoms include missed periods, facial and body hair growth, pimples, obesity, excess weight gain, bloating, hair loss, fatigue, and mood swings. Failure in diagnosing PCOD/PCOS may result in infertility, diabetes, depression, and metabolic disorders.

Traditional diagnostic methods may entail hormonal tests, ultrasound scans, insulin tests, and medical consultations that may prove to be costly or out of reach at times. The advent of technology and developments in the field of Artificial Intelligence (AI), Internet of Things (IoT), wearable sensors, and online healthcare systems have opened up new possibilities in designing affordable and intelligent women's health monitoring solutions. In this work, I present a Smart AI PCOD/PCOS Detection System – an intelligent healthcare web-based system titled “Ovuline,” which is an amalgamation of machine learning, IoT-enabled physiological monitoring, menstrual cycle tracking, and healthy lifestyle management in one solution. This smart system uses a two-tier analytical approach using AI predictions using questionnaires and IoT-assisted physiological monitoring.

The design of the system includes real-time data gathering, Firebase data syncing, Flask backend, Chart.js, and professional healthcare analysis dashboards, all without compromising on its modularity.

### 1.1 Overview

The Smart AI PCOD/PCOS Detection System adopts a multi-tier architecture that includes frontend visualization tier, backend computing tier, Machine Learning inference tier, Firebase data synchronization tier, and Internet of Things (IoT) sensing tier.

The frontend tier is implemented using React.js and shadcn/ui frameworks that allow users to visualize various dashboards including menstrual cycle calendars, ovulation tracking system, AI chatbots, and wellness tracking modules. The backend tier makes use of Python Flask APIs to process prediction requests, synchronization tasks, generate reports, perform authentication, and process sensor data.

The Machine Learning tier employs random forest classifier models trained on real healthcare data about PCOS cases to predict the probability of occurrence based on the menstrual health and hormonal conditions. IoT tier involves heartbeat sensors, body temperature sensors, insulin detection units, LCD displays, and microcontrollers that transmit physiological data to the backend via wireless networks.

Other key features include notification alerts, multilingual options, light/dark mode, life style monitoring, and professional PDF report generation capability.

### 1.2 Objectives

The key research objectives are:

- Designing and developing an intelligent AI based system to detect the early stages of PCOD and PCOS using menstrual symptoms analysis.
- Designing and developing a responsive website to track the menstrual cycles and predict ovulation.
- Designing ML models that can estimate the probability of the occurrence of PCOD and PCOS using healthcare data sets.
- Designing IoT-based physiological monitoring using heartbeat, body temperature, and insulin sensing devices.
- Developing a dashboard that could show real-time sensor outputs and health analytics.
- Designing real-time syncing using Firebase along with data storage.
- Generating professional healthcare reports in the downloadable format using Report Lab.
- Designing wellness modules such as food suggestions, hydration tracking, yoga recommendations, and sleep analytics.
- Designing a healthcare application that could provide a multilingual, accessible, and user-friendly environment.
- Designing a health ecosystem that could support wearable devices in the future.

## II. LITERATURE SURVEY

A lot of work has been done by many researchers in the areas of women healthcare analytics, prediction of hormonal disorders, IoT healthcare monitoring,

and Artificial Intelligence based healthcare system predictions.

Patel et al. [1] designed a healthcare prediction system through the use of machine learning algorithm like decision tree and random forest models to detect hormonal disorders. Their work showed that symptom based predictive model could help in predicting healthcare problems. A physiologic monitoring system using IoT to record real-time heart rate and body temperature measurements was proposed by Khan et al. [2], utilizing microcontroller-based sensing devices.

Their framework emphasized the significance of wireless healthcare systems in facilitating real-time patient monitoring. Marques et al. [3] carried out a survey on IoT healthcare architecture and highlighted the need for real-time data synchronization and cloud-independent healthcare systems to enhance security and reliability. The study provides support to the use of the modular architecture in the system proposed.

Dr. J. Narendra Babu [6][7][8][9] explored IoT applications in smart systems and emphasized combining embedded hardware with cloud connectivity for scalable IoT solutions, providing theoretical grounding for design decisions in this project.

Dr. J. Narendra Babu et al. [4] conducted research into menstrual cycle prediction systems using ovulation prediction methods based on calendars and highlighted the need for personalized menstrual analytics in female reproductive health care. Dr. J. Narendra Babu Lee [5] focused on the issues of security in health sensor networks and the need for securing the communication of data and building private healthcare frameworks.

Dr. J. Narendra Babu et al. [6] addressed the topic of artificial intelligence within healthcare systems and highlighted the growing importance of machine learning as predictive analytics and personal assistants within the sphere of healthcare.

Dr. J. Narendra Babu [7], Firebase Realtime Database [8], and Chart.js [9] are now considered

popular technologies utilized for building highly effective and scalable healthcare dashboards.

Random Forest classifier applied within this project is presented in scikit-learn [10] and is commonly known as an effective and interpretable algorithm suitable for healthcare classification based on mixed symptoms datasets.

### III. PROPOSED METHOD

The Smart AI PCOD/PCOS Detection system is designed seamlessly as integration of hardware sensing, backend processing, and frontend visualization. The proposed method involves continuous data collection from physical sensors, wireless transmission over a local Wi-Fi network, server-side storage and machine learning analysis, and real-time dashboard presentation. The following subsections describe each component of the proposed system in detail.

#### 3.1 System Architecture

The overall system architecture consists of two main levels as described below and illustrated conceptually in Figure 1.

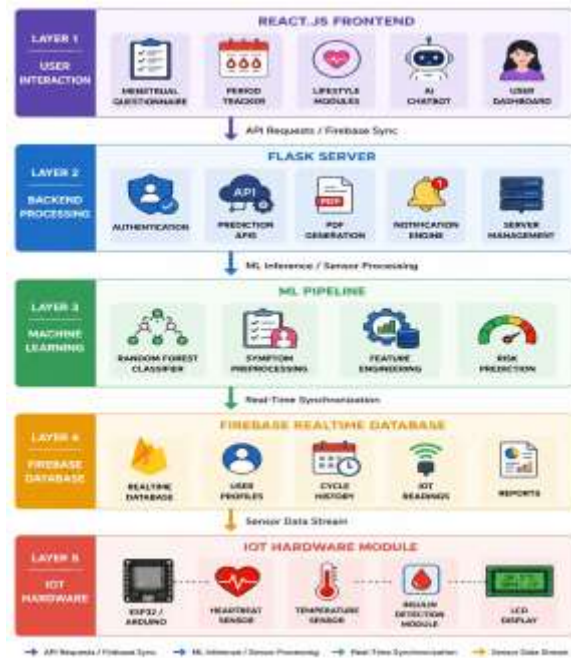


Figure 1: Two-tier system architecture of Smart AI PCOD/PCOS Detection System

Smart AI PCOD/PCOS Detection System is conceived to be an ecosystem for healthcare that uses Artificial Intelligence, IoT sensing, menstrual tracking, and healthcare analytics. The process flow consists of symptoms data acquisition, monitoring of physiological sensors, machine learning based predictive modelling, Firebase database connection, backend processing, and finally frontend healthcare visualization.

The whole system is classified into two diagnosis levels:

Level 1: AI-based menstrual symptoms analysis where manual questionnaire is done for user to predict the risks of PCOD/PCOS

Level 2: IoT-based physiological monitoring that uses sensors to predict the PCOD/PCOS

#### Concepts Used

The following technologies and concepts have been used in the proposed project:

- Predicting Menstruation Cycle
- Tracking Ovulation
- Machine Learning using Random Forest Methodology
- Firebase Synchronization Technique
- REST APIs using Flask
- Healthcare Dashboard
- IoT Sensors
- Chart.js Analytics
- PDF Medical Reports
- AI chatbot for help
- Notification Services
- Web Responsive Designs
- Dark/Light Themes
- Multilingual UI

## IV. MODULES DESCRIPTION

### 4.1 Menstrual Tracking Module

This module allows users to input menstrual cycle history, abnormalities, ovulation period, PMS signs, and duration of the cycle.

The calendar displays the dates of menstruation in red and the ovulation period in yellow.

### 4.2 AI Prediction Module

AI prediction module analyzes questionnaire responses utilizing Random Forest Classifier based on datasets related to PCOS. Pre-processing, feature encoding, probability estimation, and risk prediction are performed before delivering the results.

### 4.3 IoT Monitoring Module

The IoT module gathers information about body temperature, heartbeat rate, and insulin-related measurements using connected sensors and MCU. The sensor information is sent via Bluetooth from the MCU to the Flask server.

### 4.4 Backend Module

This module handles authentication, Flask API routing, machine learning model predictions, syncing with Firebase database, report creation, and notifications.

### 4.5 Frontend Dashboard Module

Dashboard includes:

- real-time healthcare metrics readings
- AI prediction outcomes
- menstrual cycles history
- analyzed cycle data
- PMS signs
- wellness data

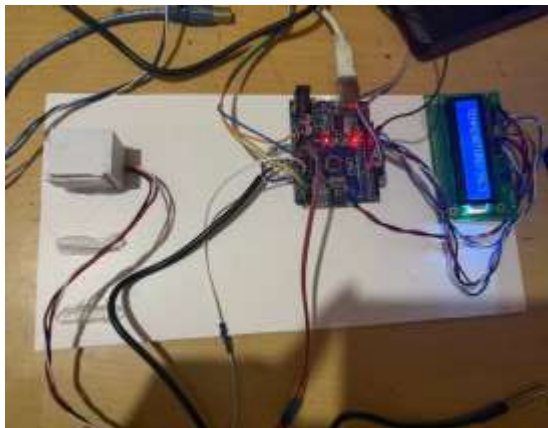
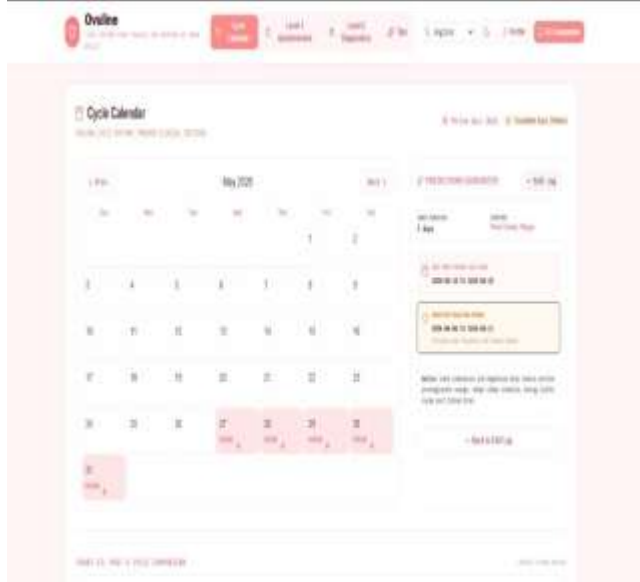
Charts and graphs are created using Chart.js library.

### 4.6 Lifestyle & Wellness Module

The wellness module offers recommendations for:

- healthier diet
- proper yoga poses
- water intake monitoring
- sleep quality
- wellness

## V. RESULTS



Hardware output

The Smart AI PCOD/PCOS Detection System was evaluated using actual questionnaire datasets and simulated IoT communication pipelines through laboratory tests. The menstrual tracking component was able to store and show previous menstrual cycle history while generating ovulation prediction with precise cycle duration analysis.

The Random Forest Machine Learning classifier performed well during its preliminary test phase by giving reliable symptom-related risk estimation results. The Flask backend system was able to process API requests as well as synchronizing information in Firebase Realtime Database with no apparent delays.

The frontend interface was responsive both for desktops and mobiles while being able to visualize healthcare analytics and cycle history graphs precisely. The PDF report generator was successful in producing professional clinical reports with accurate cycle history, prediction results, and health metrics.

The IoT integration framework was able to receive physiological readings from connected sensors and showed them in real-time healthcare dashboards. The notification system was efficient in delivering reminders for missed menstrual cycles, hydrations, and wellness activities.

The project was able to integrate AI, IoT, ML, Firebase synchronization, and healthcare visualizations into a functional healthcare monitoring environment.

## VI. CONCLUSION

This paper introduced the Smart AI PCOD/PCOS Detection System, which is a comprehensive healthcare system that can be used to detect any signs of hormonal disorders and help monitor menstrual health awareness and provide a personalized healthcare environment based on Artificial Intelligence and Internet of Things techniques.

The developed system was able to integrate menstrual symptoms analysis, Machine Learning algorithms, and IoT technologies into one healthcare environment for prediction and analysis purposes. Firebase synchronization and Flask API were effectively used to create a scalable and cost-effective women's health care monitoring system.

The modular design applied in this system makes sure that in the coming years more sophisticated technologies such as advanced clinical data analysis, cloud computing, wearable, and deep learning models could be applied to this platform.

In the coming years, ultrasound report analysis, lab tests analysis, smart watch synchronization, LSTM algorithm, multilingual AI health care assistants, and telemedicine integration will be considered as improvements of this system.

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