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Integration of an ESP32-Based EOG Device with AI Systems for Medical Diagnosis

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Introduction

- ESP32-based device for real-time ECG monitoring
- Combines data acquisition, visualization, and AI analysis
- Aim: Enhance accuracy and speed in cardiac diagnostics

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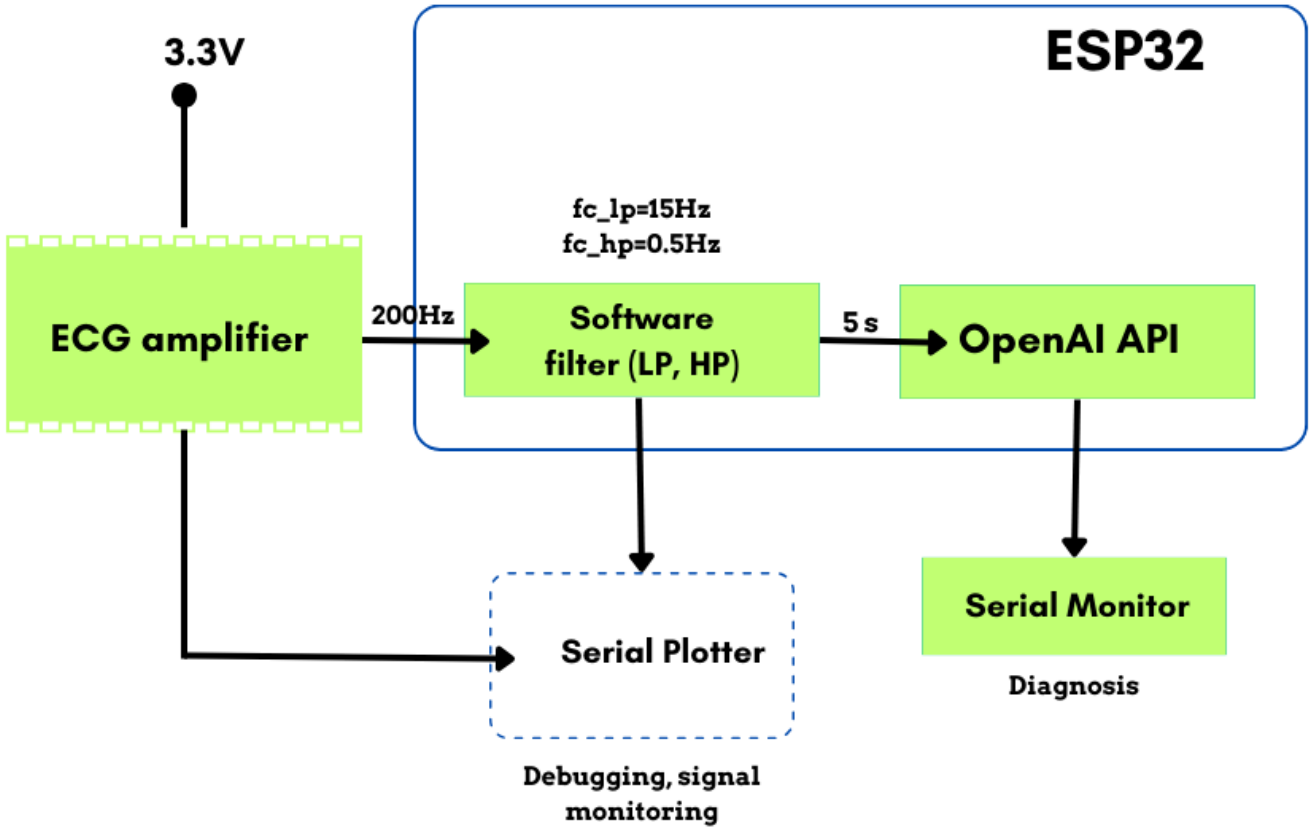
Block Diagram Overview



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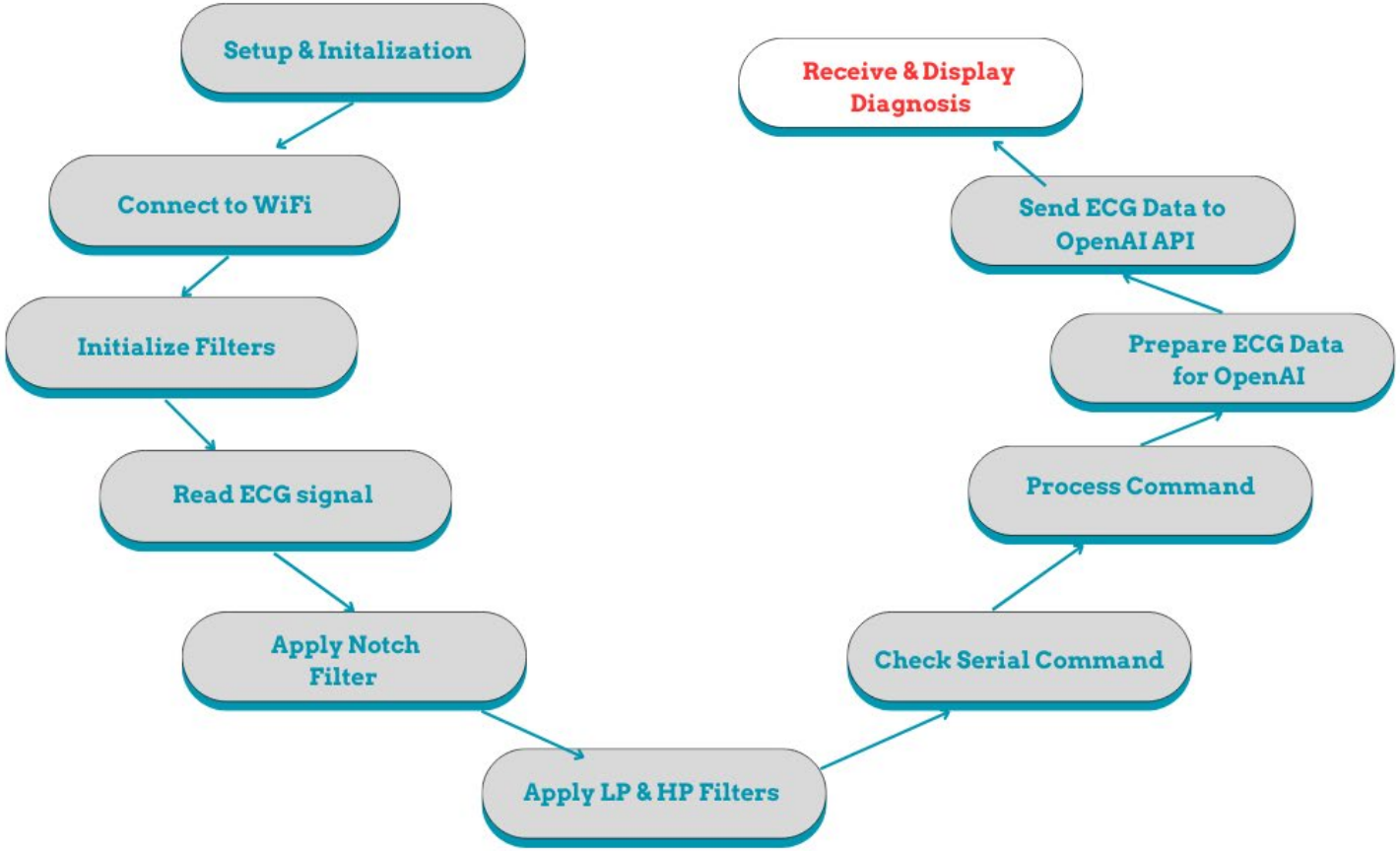
System Workflow Diagram



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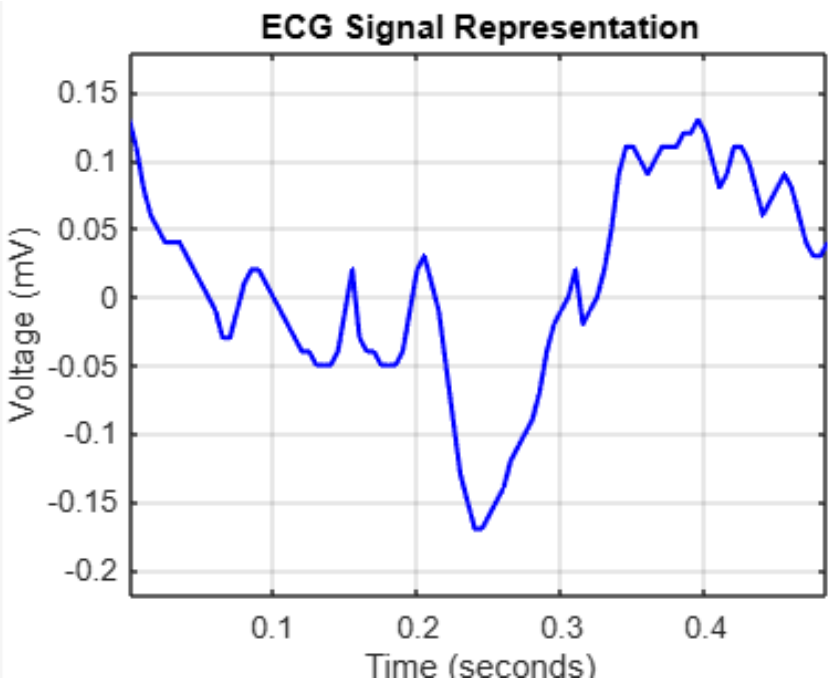
Experimentation Overview

- Read Command: Captures raw ECG signals from AD8232 via ESP32 ADC

The system collected voltage samples at a 200 Hz sampling rate,

formatted as (time, voltage) pairs.



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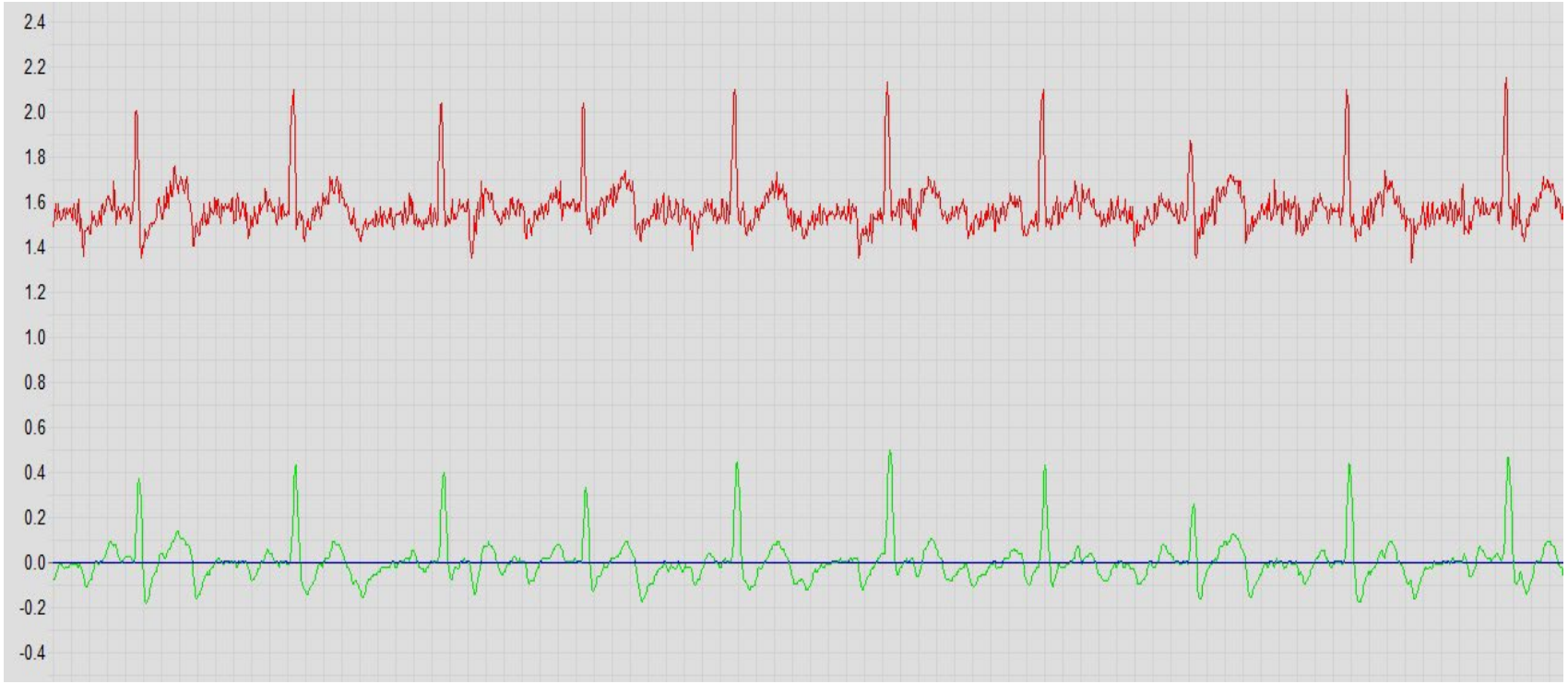
Experimentation Overview



- **Show Command:** Visualizes real-time ECG waveforms

A direct analog signal representation as captured by an oscilloscope.

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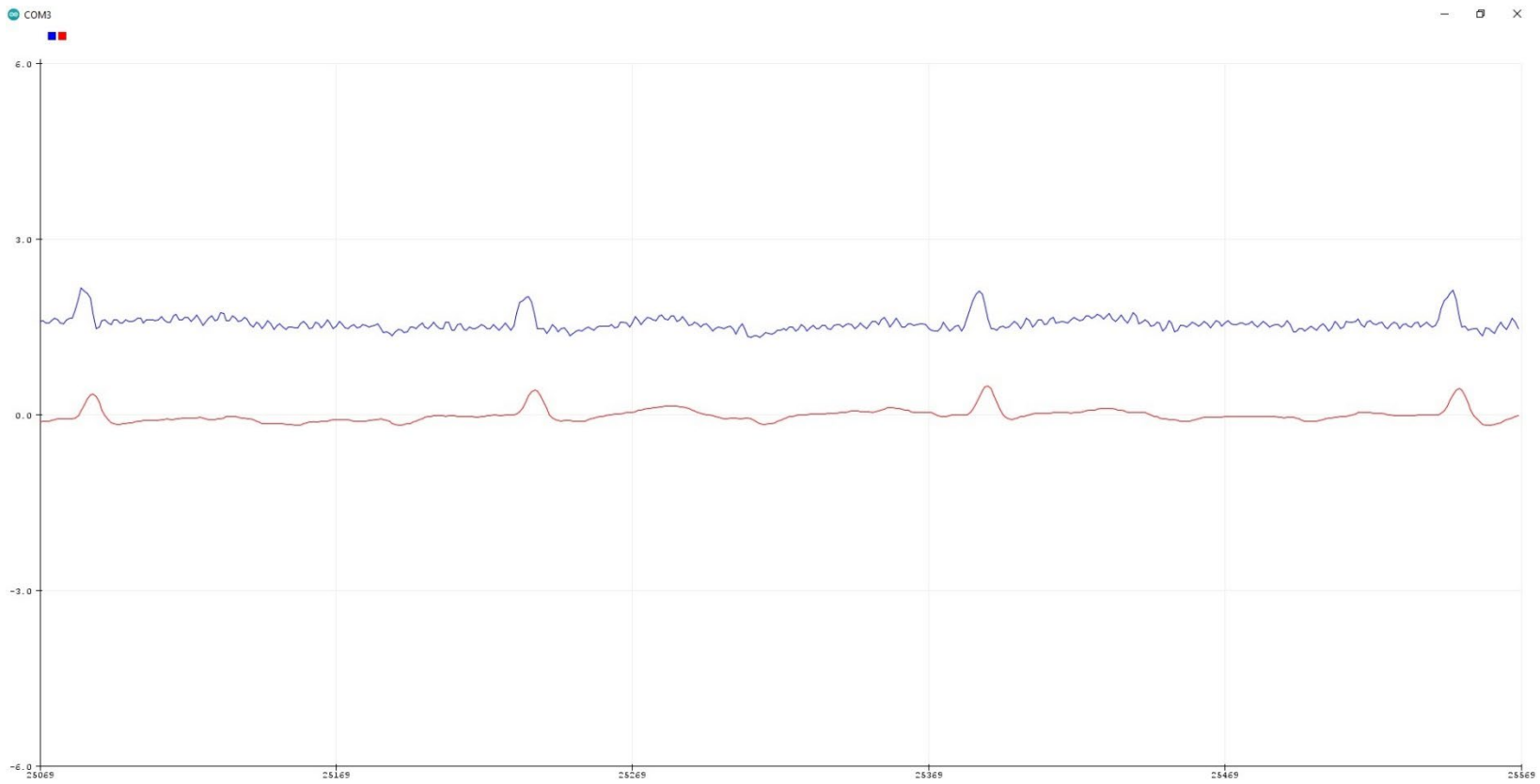
Experimentation Overview



- Show Command: Visualizes real-time ECG waveforms

A real-time graphical visualization using the Arduino Serial Plotter.

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Experimentation Overview

- Analyze Command: Utilizes AI for ECG interpretation and diagnostic insights

Possible Interpretations:
- **Normal Sinus Rhythm: Given the lack of significant deviations from baseline and the absence of abnormal waveforms, this could represent a normal sinus rhythm,**
albeit without clear identifiable features in the data provided.
- **Artifact or Noise: The data could also represent a form of electrical noise or artifact, particularly if this data was collected in a non-clinical setting or if there was poor electrode contact.**
Conclusion:
Based on the provided ECG data, there are no clear indicators of pathological conditions. The data suggests a stable heart rhythm with no significant abnormalities. However, for a definitive diagnosis, a visual inspection of the ECG waveform and additional clinical context would be necessary. If there are symptoms or concerns, further evaluation with a complete ECG and clinical assessment would be warranted.

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AI vs. Traditional ECG Analysis

- **Accuracy:** AI detects complex arrhythmias and subtle waveform variations
- **Efficiency:** Enables near real-time analysis, faster than manual review
- **Diagnostic Capability:** Offers insights beyond standard rule-based methods
- **Limitations:** AI functions as a “black box” with less transparency

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Key Applications

- **Remote Cardiac Monitoring:** Continuous patient monitoring with early alerts
- **Telemedicine:** Enhances diagnostic capabilities in rural and underserved areas
- **Chronic Disease Management:** Supports early intervention and ongoing patient care
- **Emergency Response:** Provides on-demand ECG analysis in urgent situations
- **Healthcare Efficiency:** Reduces ER visits, optimizes physician workload, cuts costs

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Challenges & Limitations

- **API Constraints:** Rate limits and token budgets restrict continuous analysis
- **Network Reliability:** Dependence on Wi-Fi and cloud services may cause interruptions
- **AI Limitations:** Risk of false positives/negatives; requires clinical oversight
- **Regulatory/Ethical Considerations:** Needs certification, unbiased training, and clear communication

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Conclusion & Future Work

- IoT & AI ECG monitoring is feasible
- Detects cardiac abnormalities in real time

Future Work:

- Add sensors (SpO_2, blood pressure)
- Conduct clinical validation
- Improve user interface

Thank you for your attention!

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