Extracting Abnormalities from Raw signal

Theory

Photoplethysmography (PPG) is an optical technique used to measure blood volume changes in the microvascular tissue. It is widely used in heart rate monitoring, oxygen saturation measurement, and detecting cardiovascular abnormalities.

Key Steps in Abnormality Detection:

Signal Acquisition: The raw PPG signal is obtained from a sensor.

1. **Preprocessing**:

***Filtering**: Remove noise using a bandpass filter (e.g., Butterworth filter).

***Smoothing**: Apply moving average or Savitzky-Golay filter.

***Baseline Correction**: Use detrending techniques.

2.Feature Extraction:

1. Peak detection to find heartbeats.
2. Heart rate variability (HRV) analysis.
3. Amplitude and pulse width analysis.

3.Abnormality Detection:

1. Arrhythmia detection using HRV.
2. Low-amplitude or irregular peaks indicating potential health issues.

4.Signal Acquisition: The raw PPG signal is obtained from a sensor.

5.Feature Extraction:

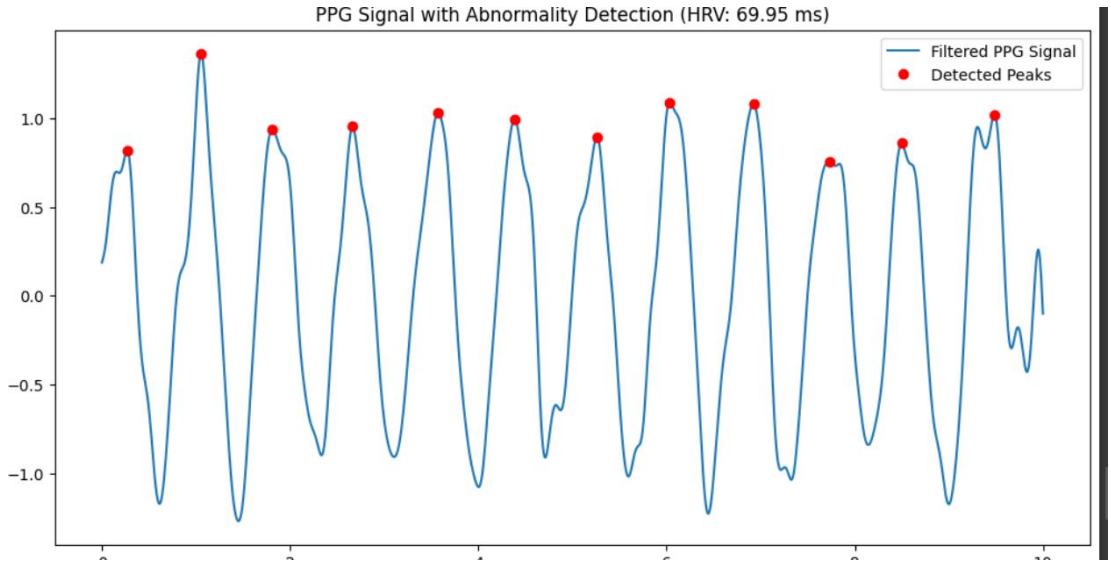
3. Peak detection to find heartbeats.
4. Heart rate variability (HRV) analysis.
5. Amplitude and pulse width analysis.

CODE:

```
import numpy as np
```

```
import matplotlib.pyplot as plt
from scipy.signal import butter, filtfilt, find_peaks

# Load sample PPG data (Replace with real data)
fs = 100  # Sampling frequency (Hz)
t = np.linspace(0, 10, fs * 10)  # 10 seconds signal
ppg_signal = np.sin(2 * np.pi * 1.2 * t) + 0.5 * np.random.randn(len(t))  # Simulated PPG

# Bandpass filter design
def bandpass_filter(data, lowcut=0.5, highcut=5, fs=100, order=3):
    nyquist = 0.5 * fs
    low = lowcut / nyquist
    high = highcut / nyquist
    b, a = butter(order, [low, high], btype='band')
    return filtfilt(b, a, data)

filtered_ppg = bandpass_filter(ppg_signal)

# Detect peaks (Heartbeats)
peaks, _ = find_peaks(filtered_ppg, height=0.2, distance=fs//2)

# Compute Inter-Beat Interval (IBI) and HRV
ibi = np.diff(peaks) / fs
hrv = np.std(ibi) * 1000  # Convert to milliseconds

# Plot Results
plt.figure(figsize=(12, 6))
```

```
plt.plot(t, filtered_ppg, label="Filtered PPG Signal")

plt.plot(t[peaks], filtered_ppg[peaks], "ro", label="Detected Peaks")

plt.xlabel("Time (s)")

plt.ylabel("Amplitude")

plt.legend()

plt.title(f"PPG Signal with Abnormality Detection (HRV: {hrv:.2f} ms)")

plt.show()


# Detect abnormal HRV

if hrv > 100:  # Threshold for irregular heart rate

   print("Warning: Abnormal HRV detected!")

else:

   print("HRV is within normal range.")
```



PPG Signal: Theory and Code

Theory

Key Steps in Abnormality Detection: