Heart Rate Measuring Using Mobile Phone's Camera

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Heart rate

- **Heart rate** is the number of times the heart beats per minute
- **Heart rate** gives information about the extent of physical training of the person
- High or low **heart rate** is a signal to check circulatory system

Ways to measure heart rate

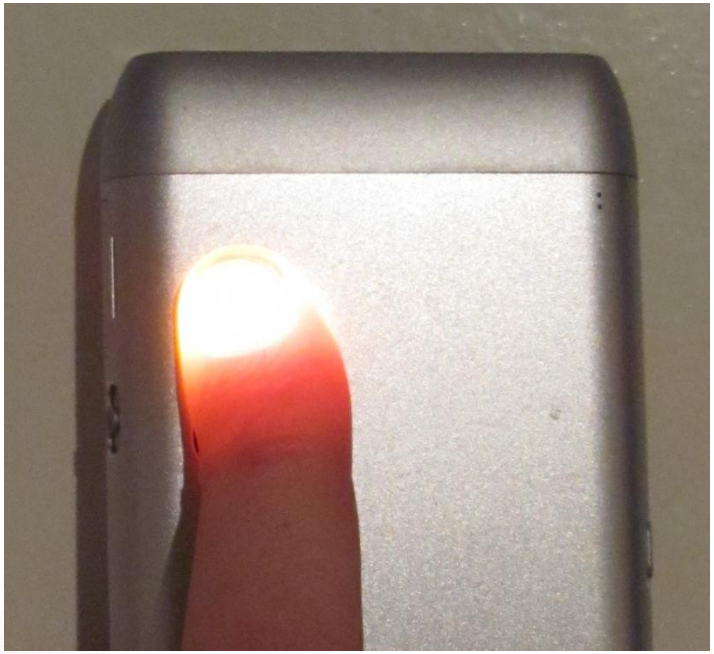
Ways to measure heart rate

Measure heart rate with smartphone

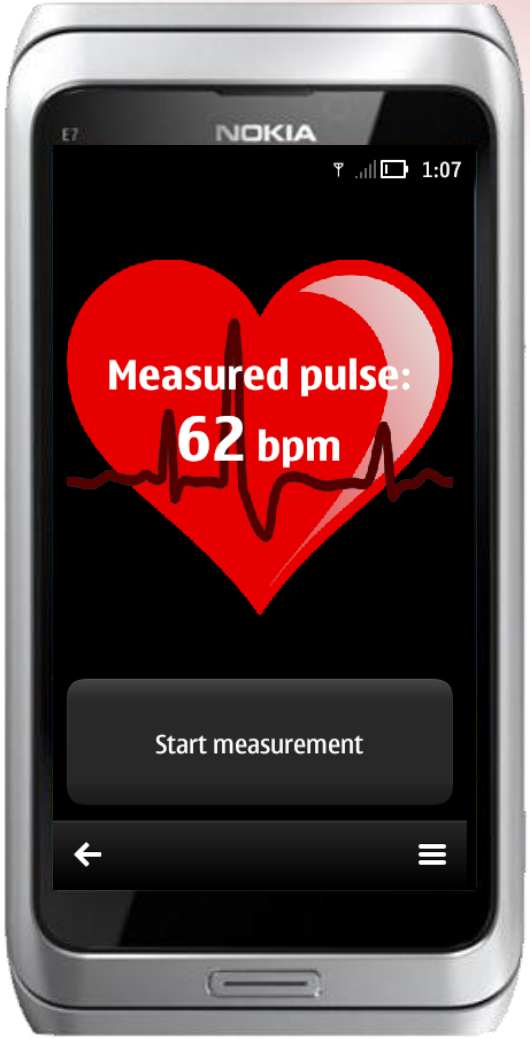
Requirements:

- built-in camera with flash
- special application installed

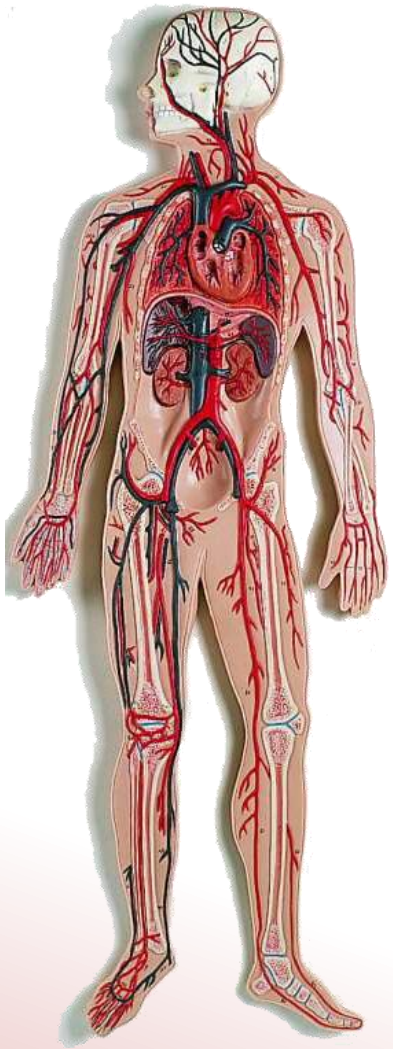
User scenario



after some time



How it works from the inside

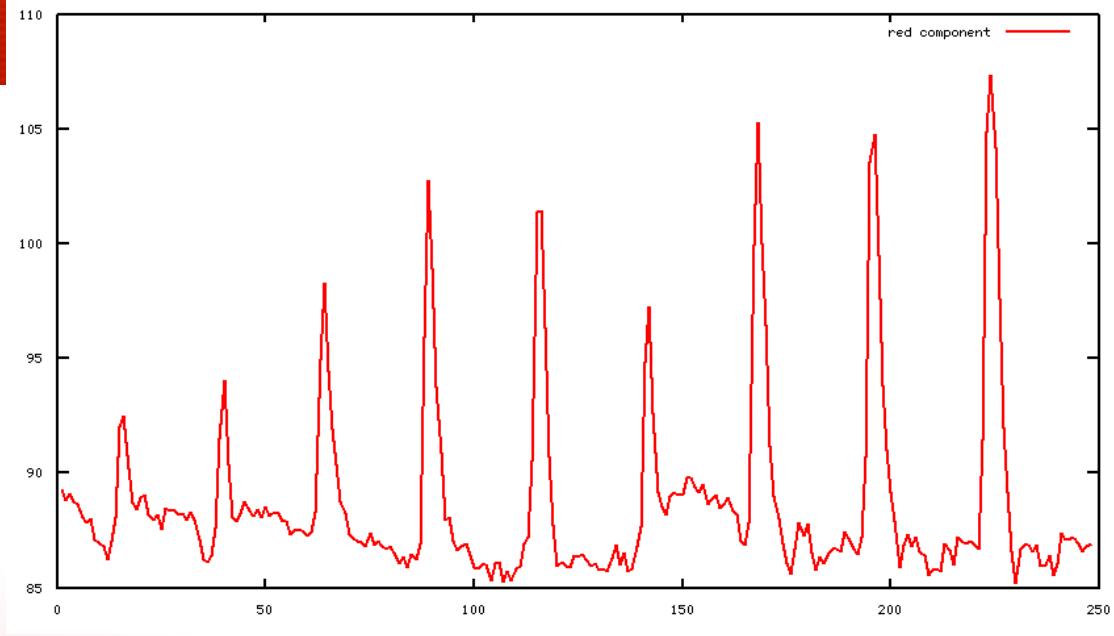


- Every time heart beats, it pushes the blood to every part of human body
- This pulsation changes the color and opacity of the skin in the part of human body, where vessels are close to the skin

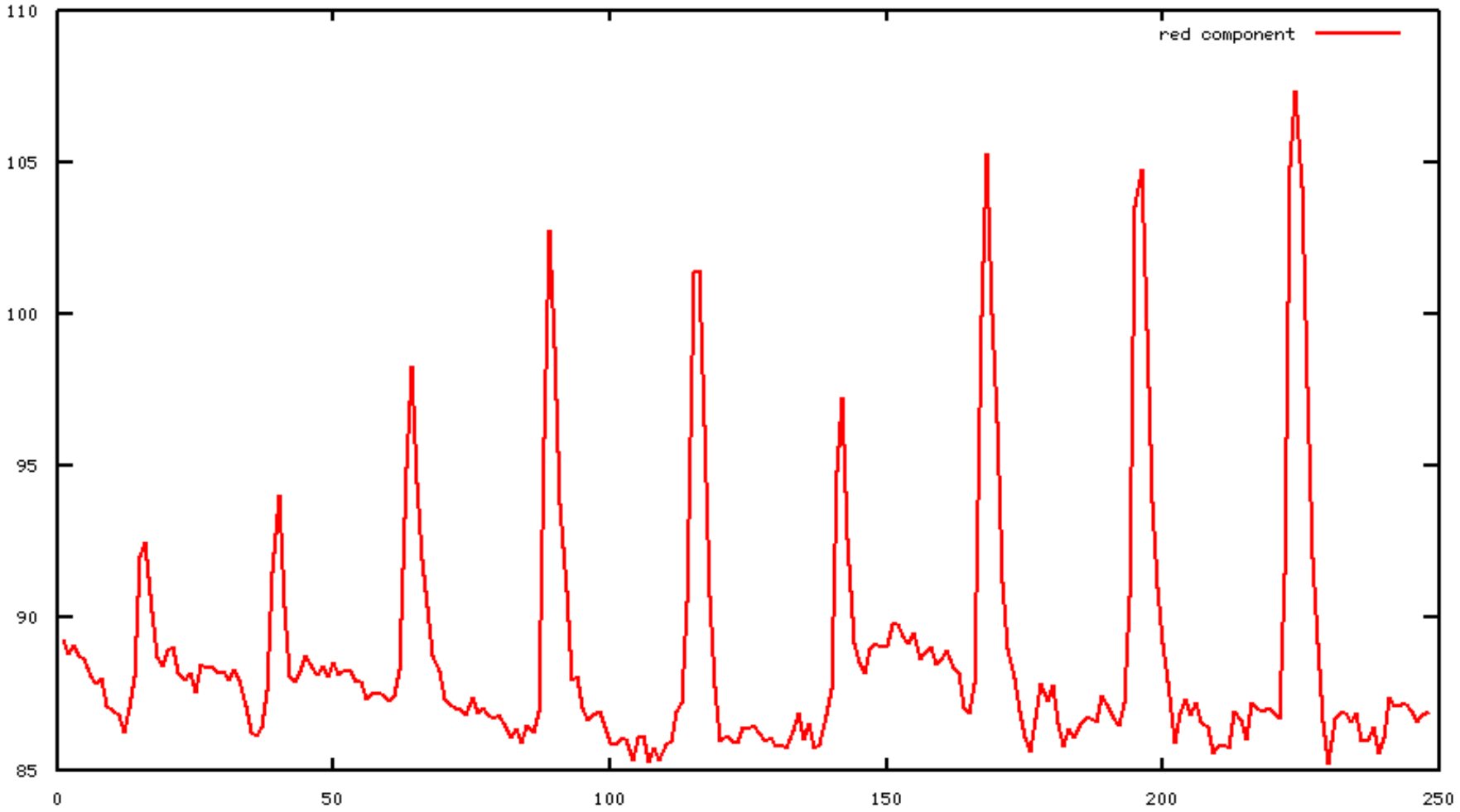
Capturing video

Capturing video

plot graph of the red components of the frames

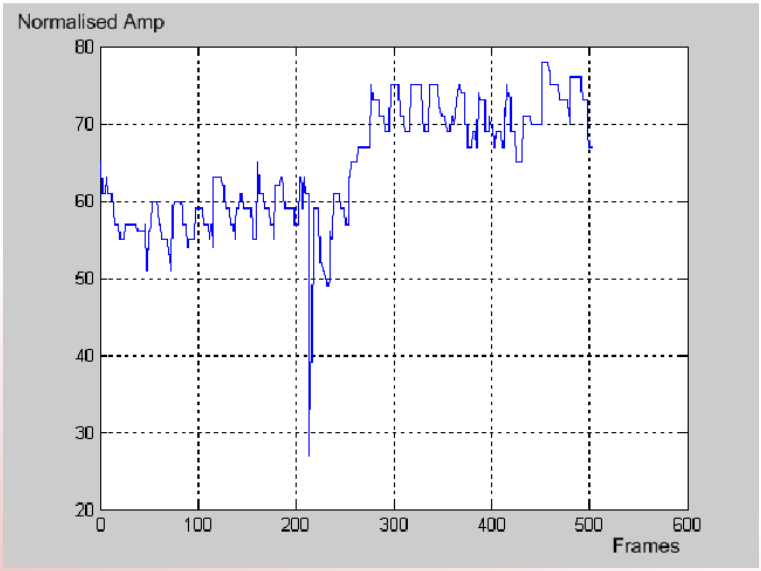


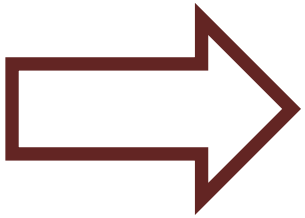
Red components graph

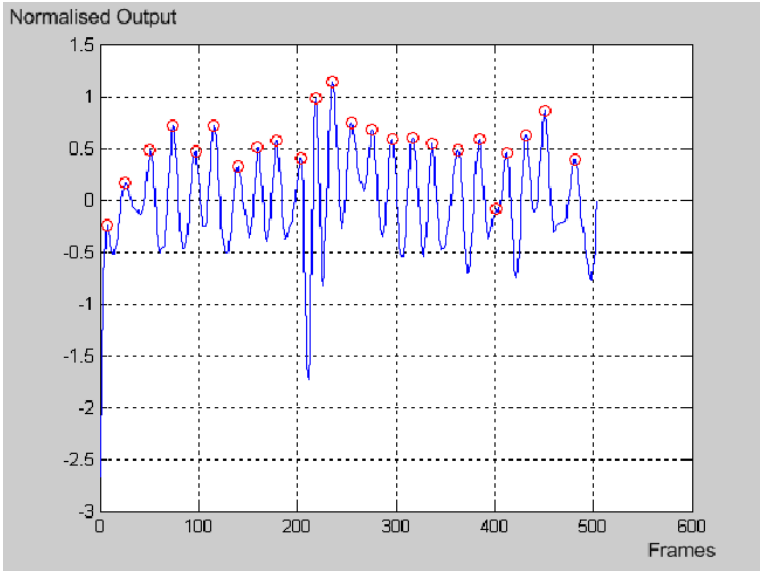


Peak detection algorithms

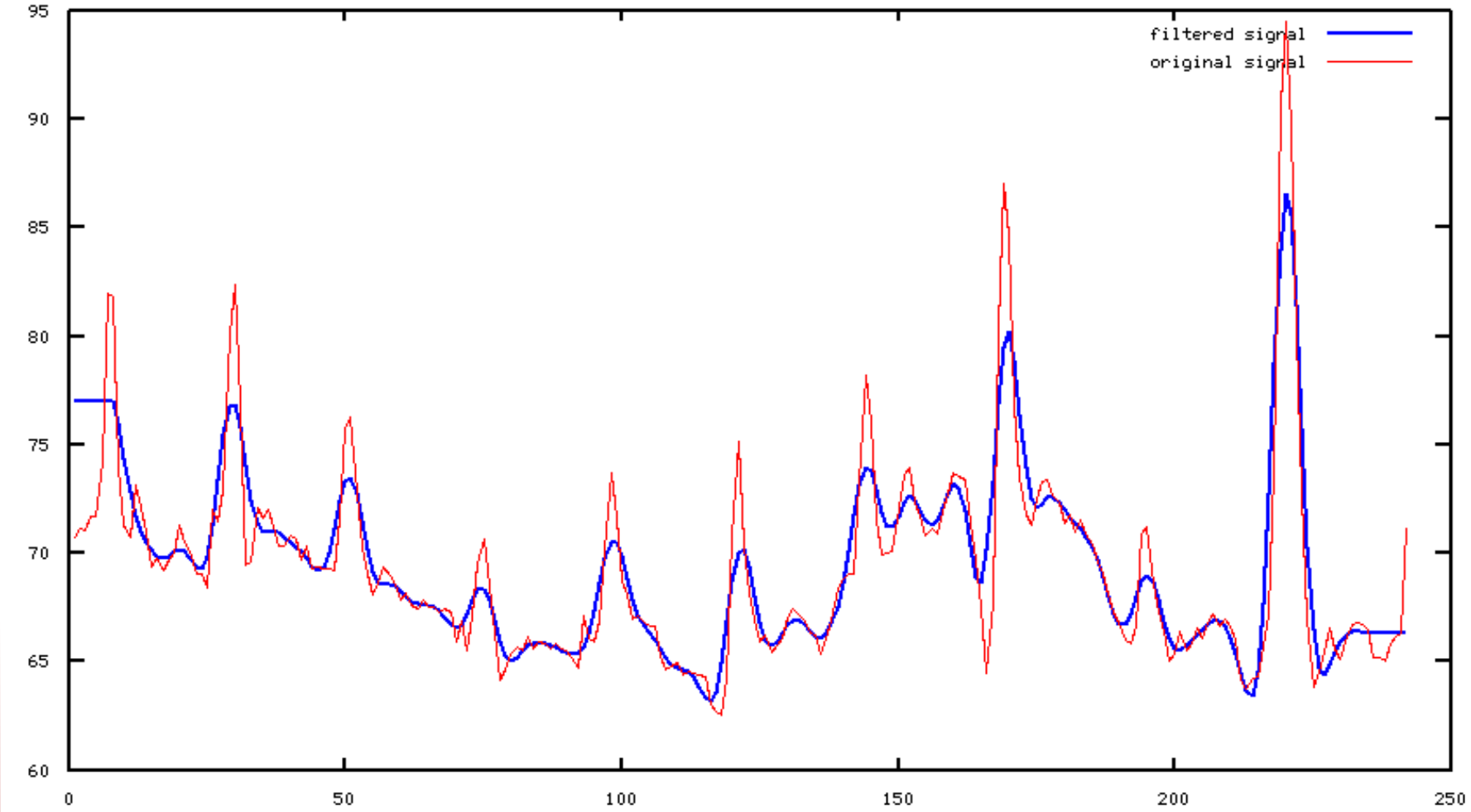
- Normalizing signal using smooth differentiation (Banitsas K. and others “A Simple Algorithm to Monitor HR for Real Time Treatment Applications”)
- Filtering signal with a moving average filter (Chandrasekaran, V. “Measuring Vital Signs Using Smart Phones”)



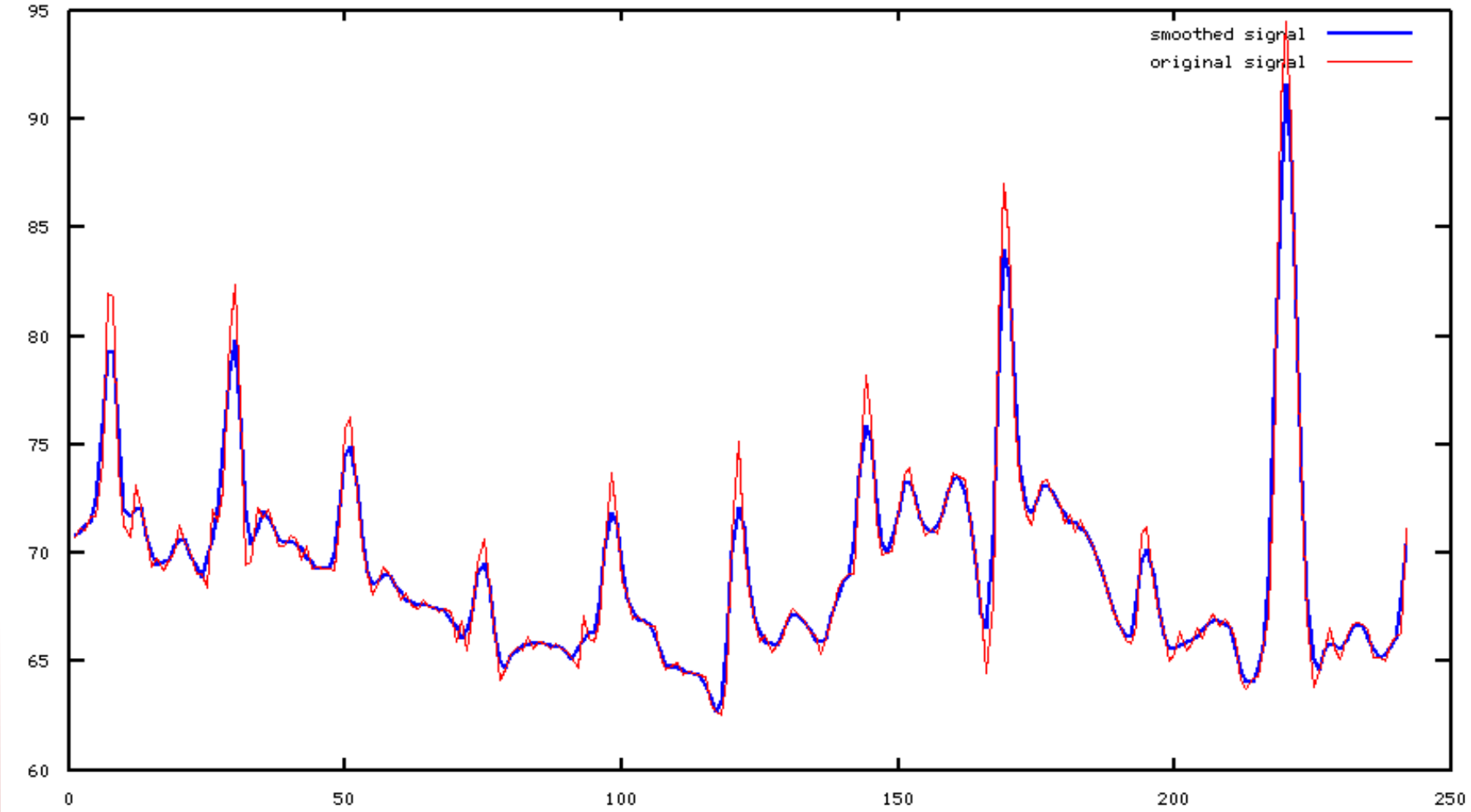




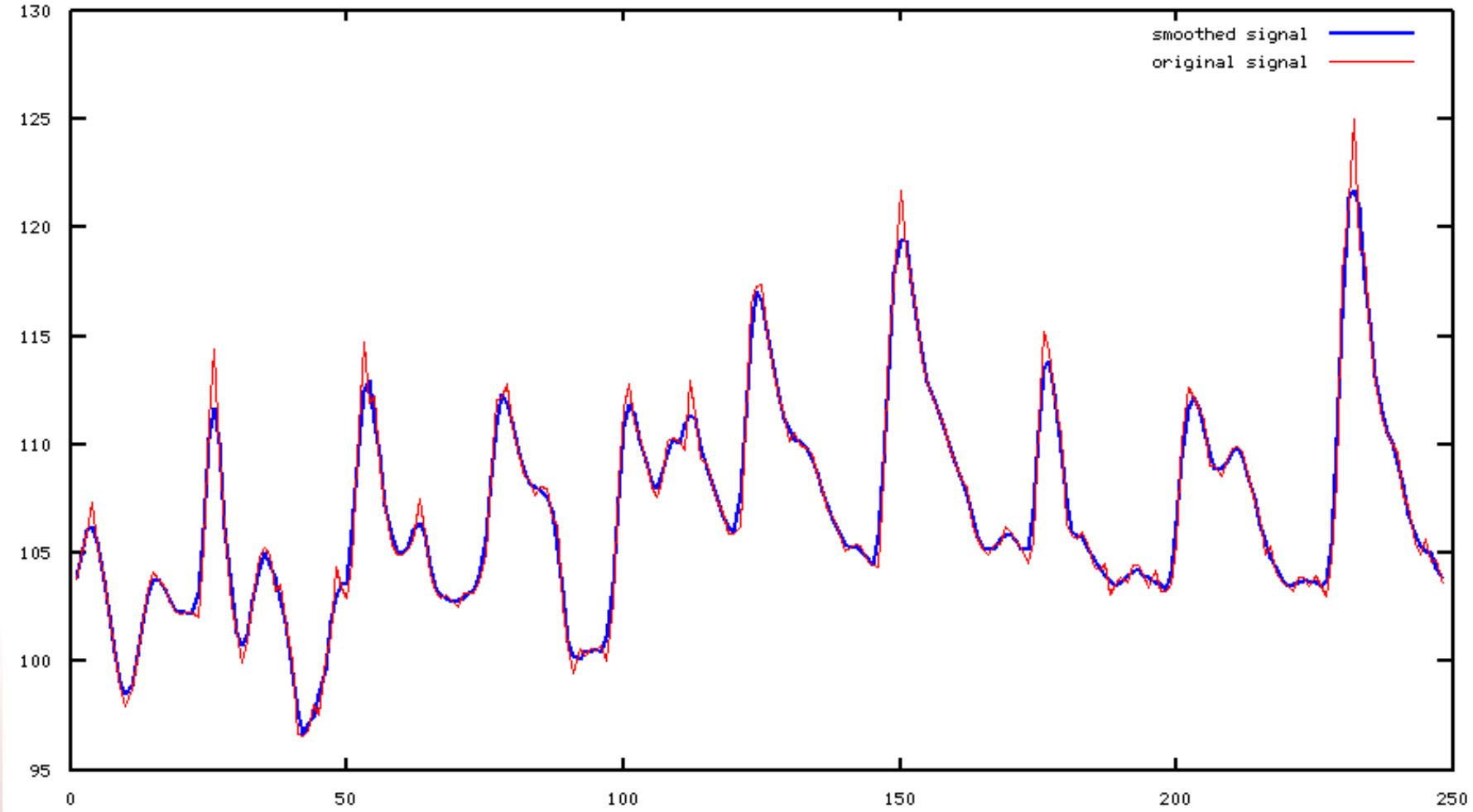
Fake peaks (1/4)



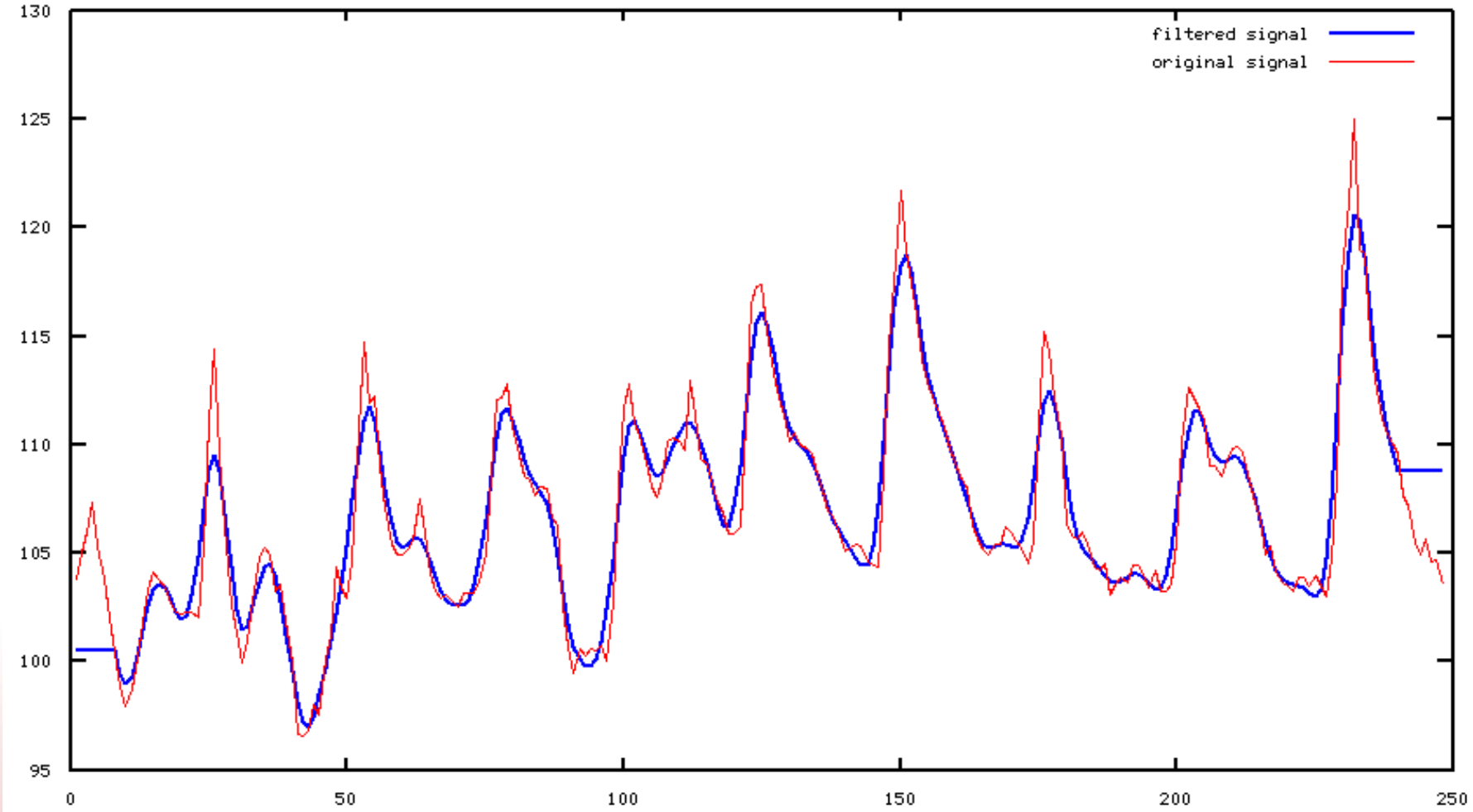
Fake peaks (2/4)



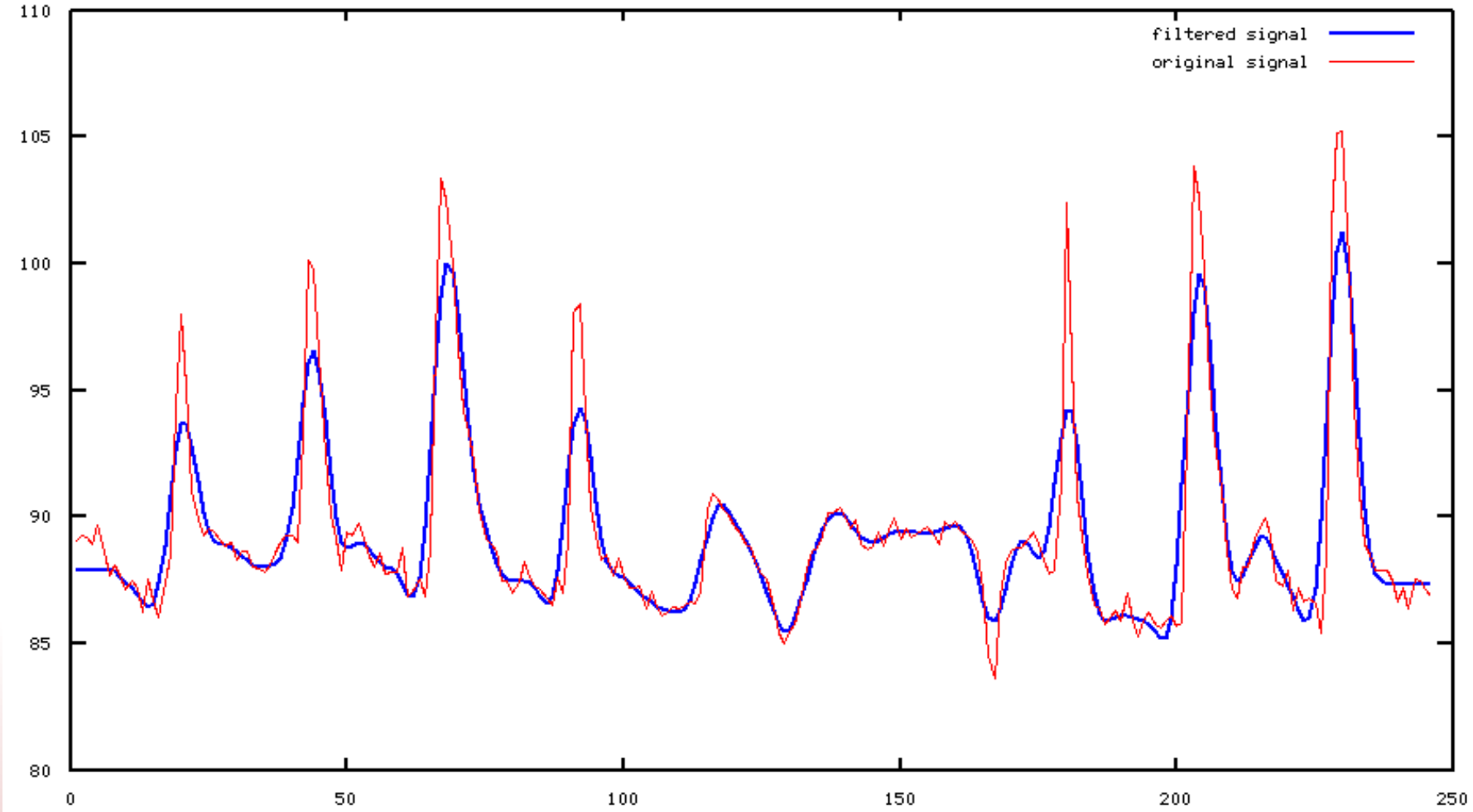
Fake peaks (3/4)



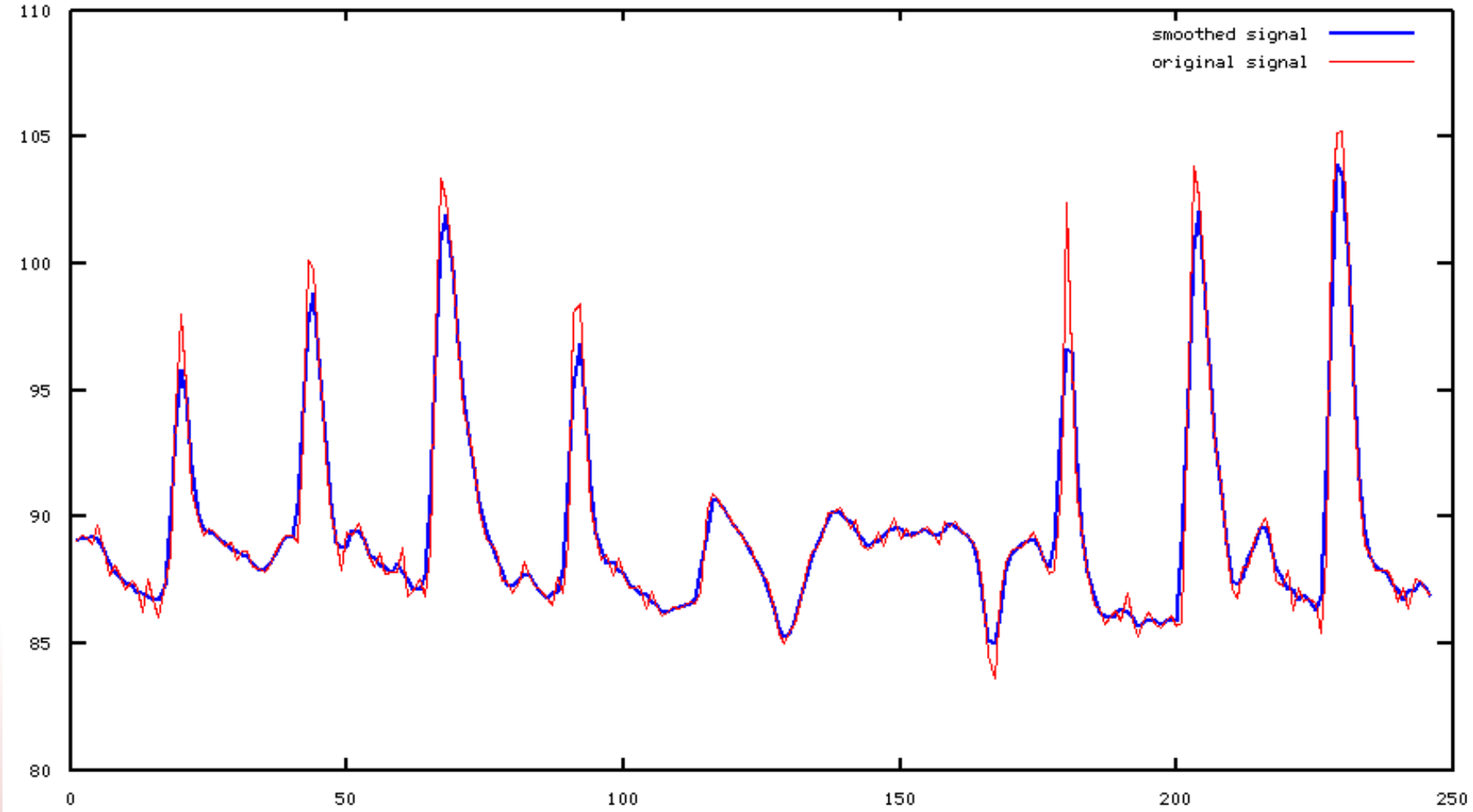
Fake peaks (4/4)



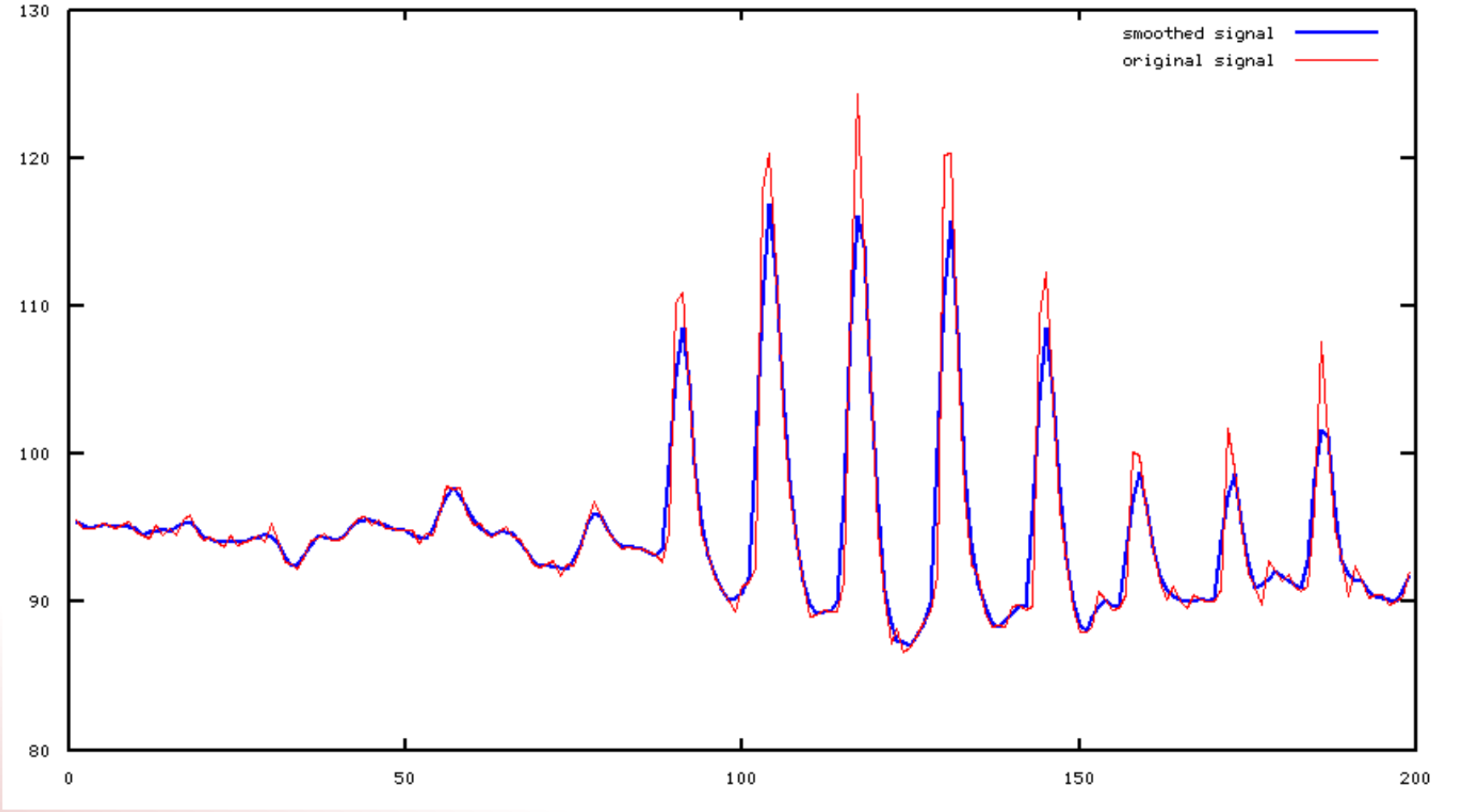
Lost signal (1/4)



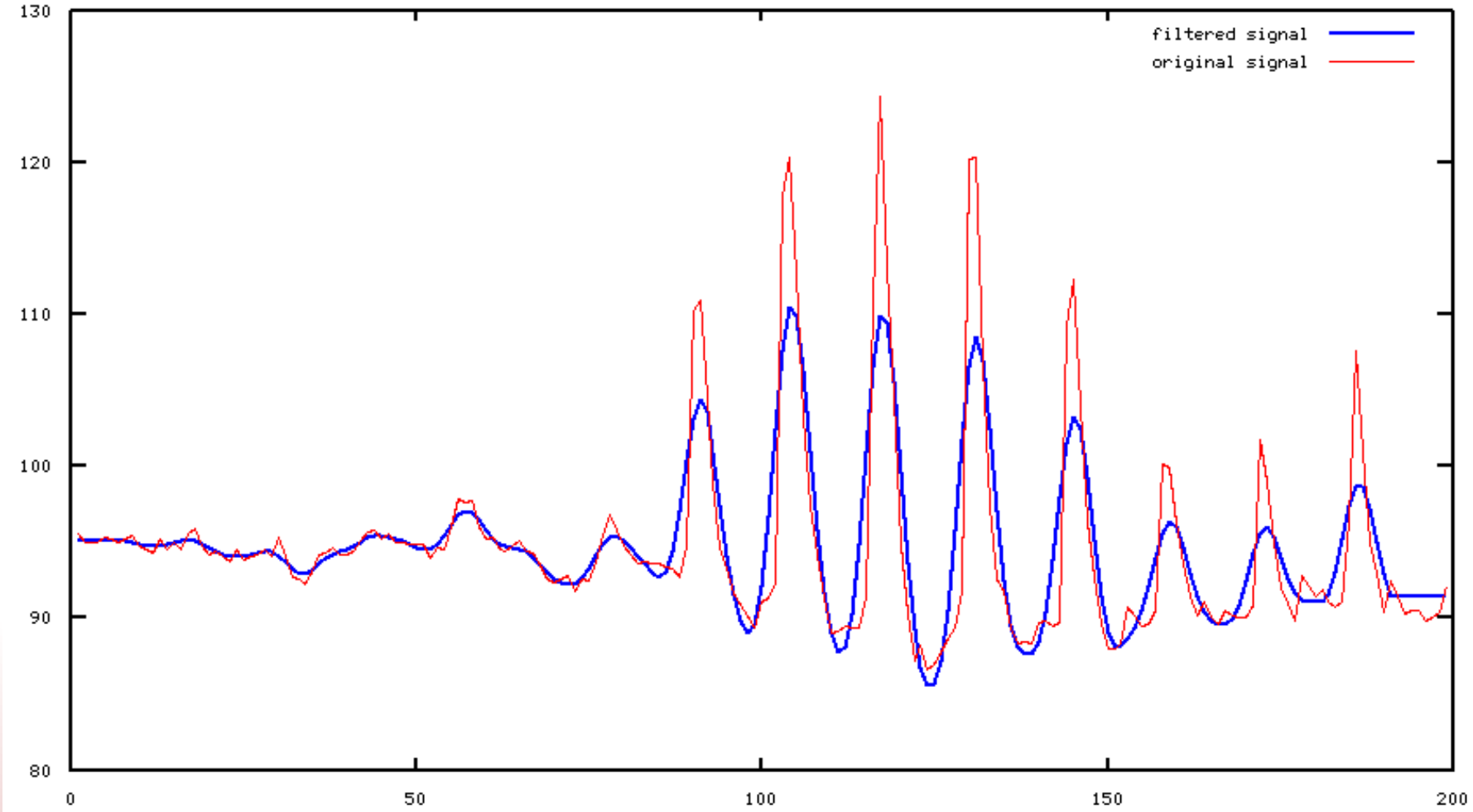
Lost signal (2/4)



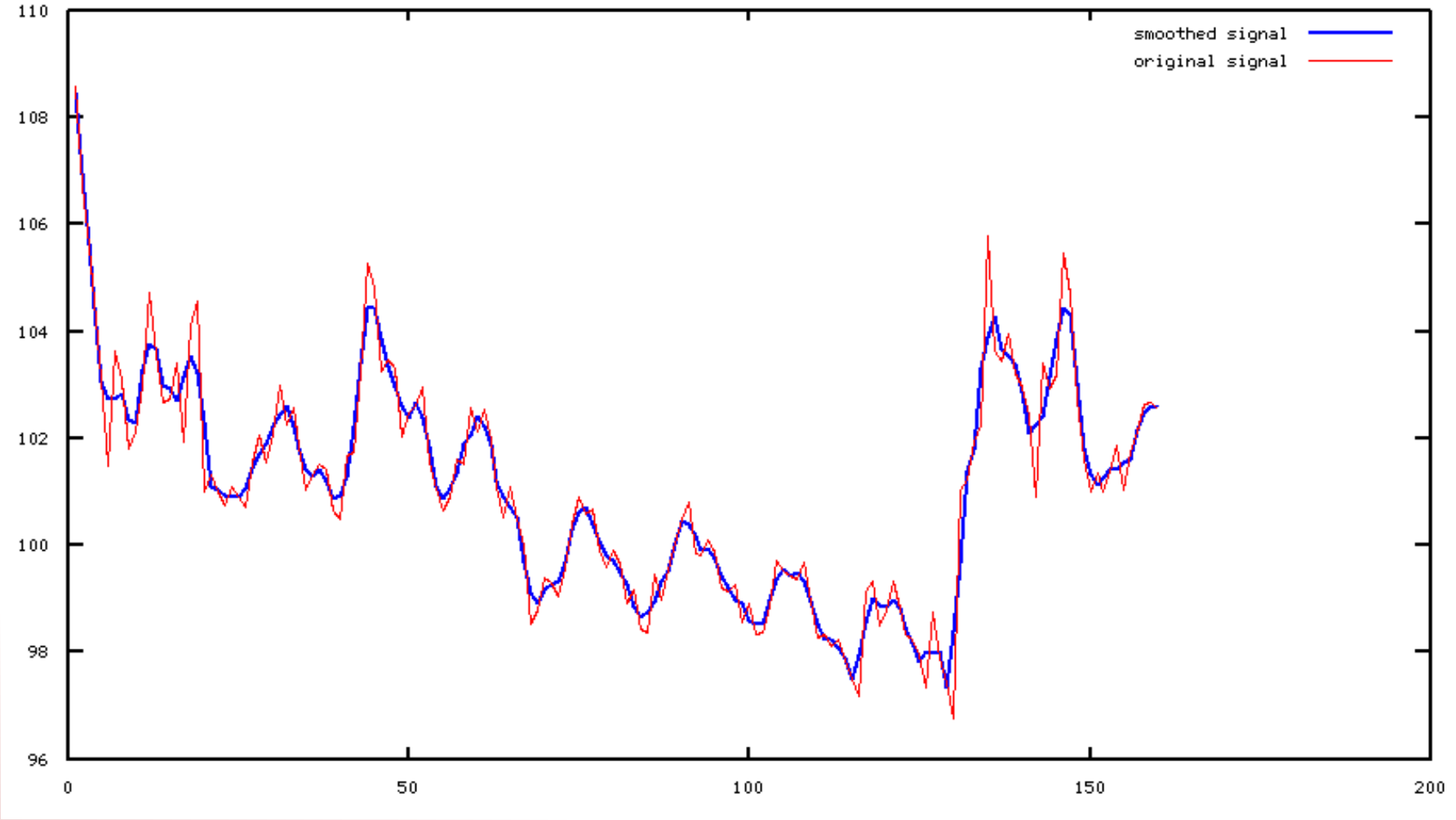
Lost signal (3/4)



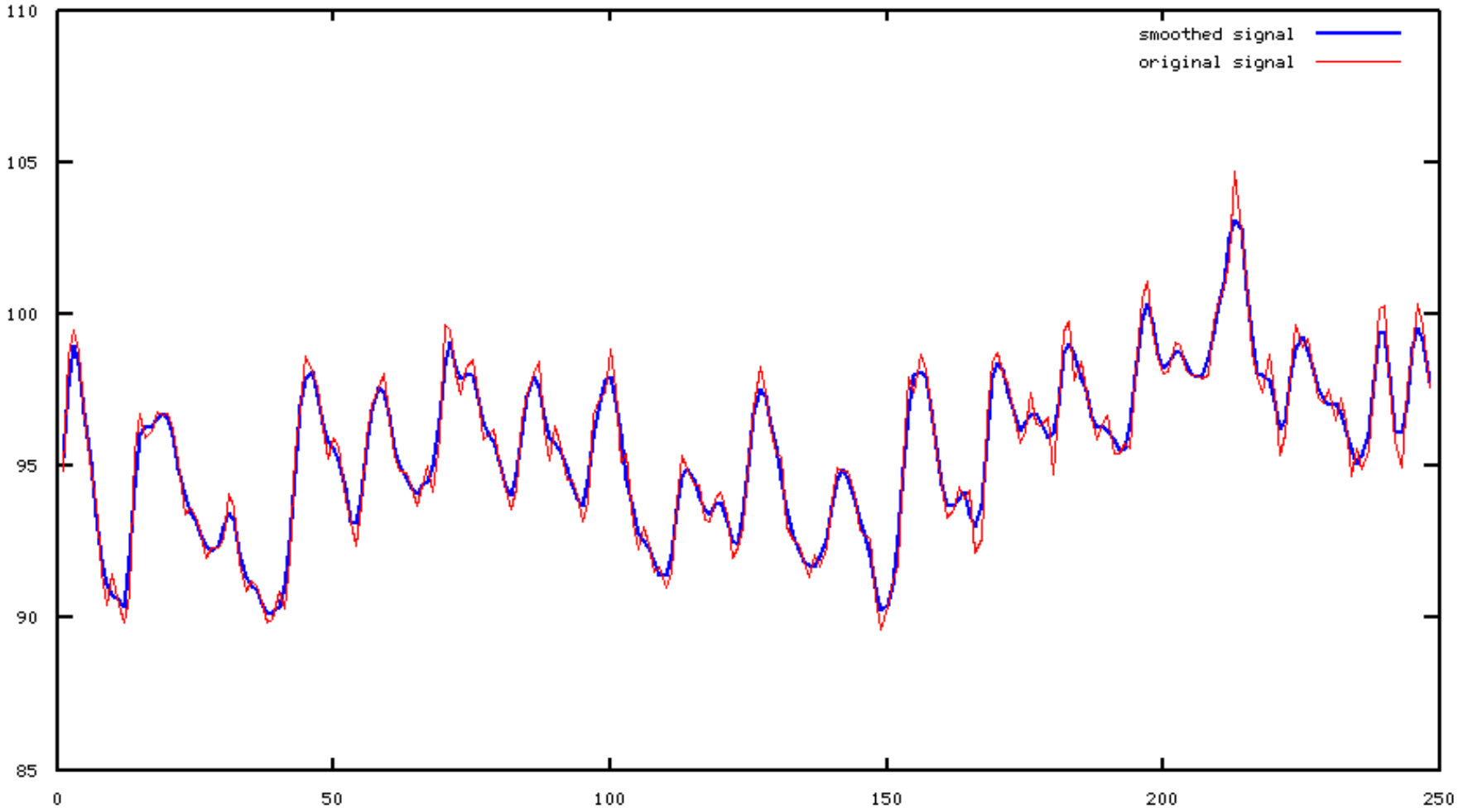
Lost signal (4/4)



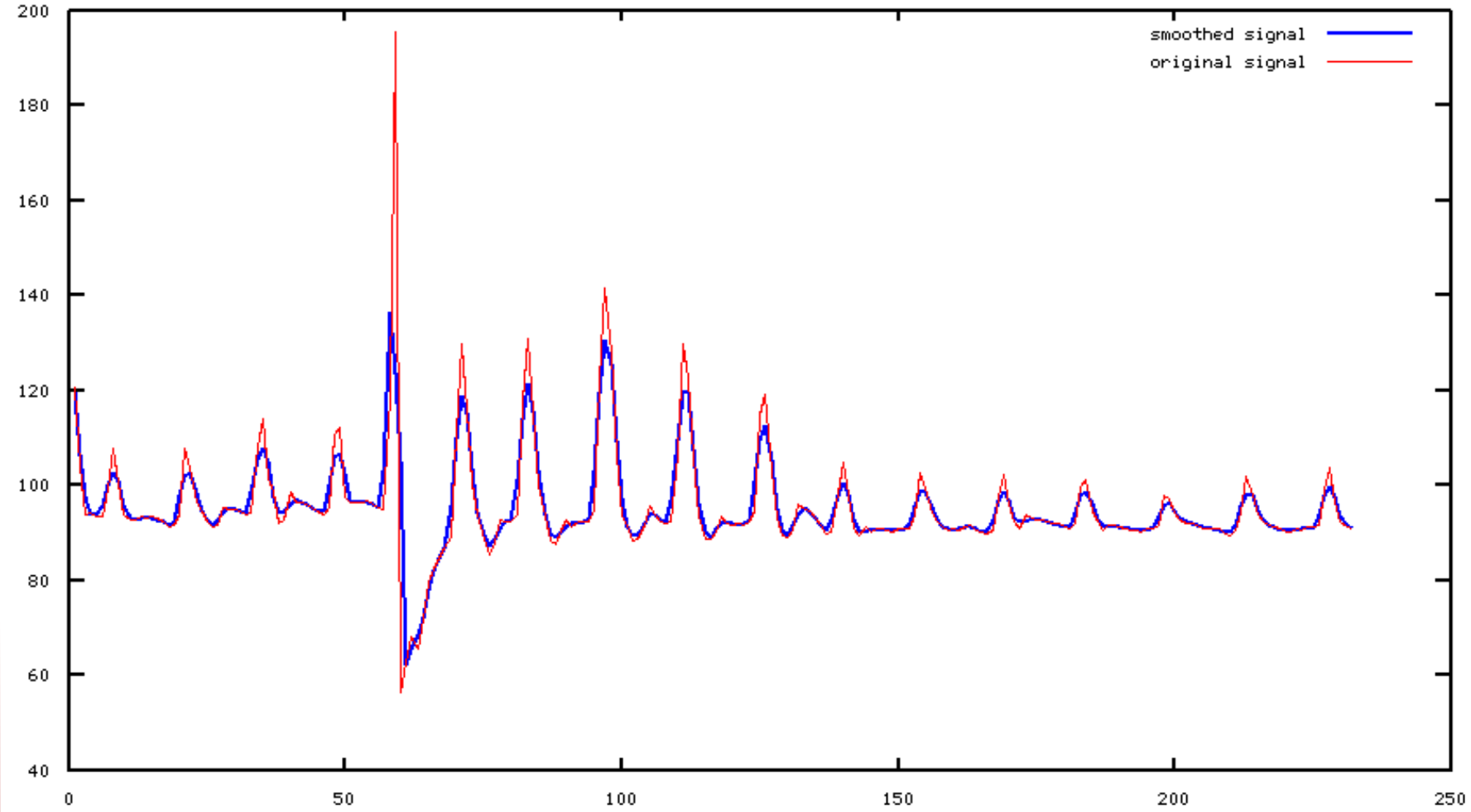
Different height peaks (1/4)



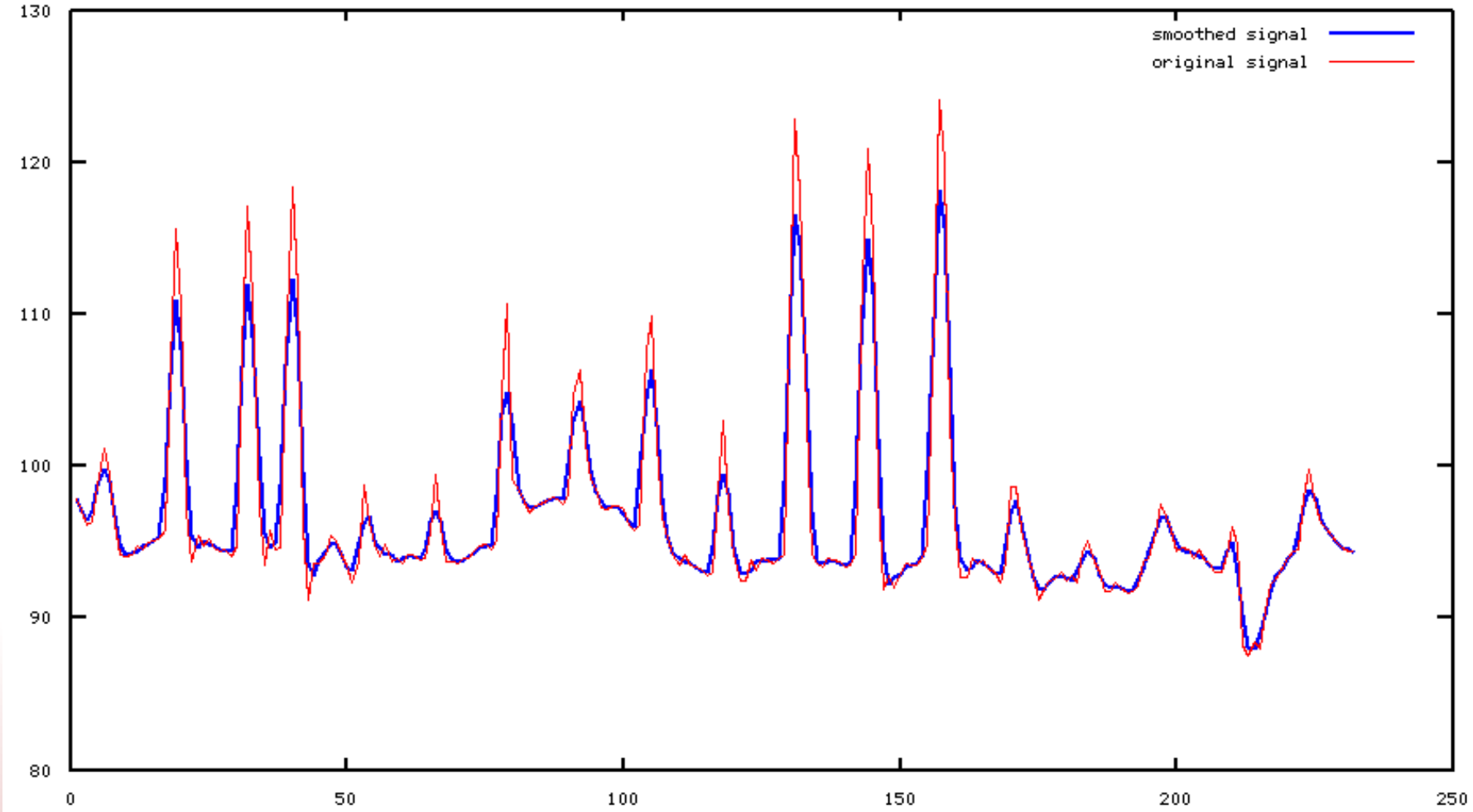
Different height peaks (2/4)



Different height peaks (3/4)



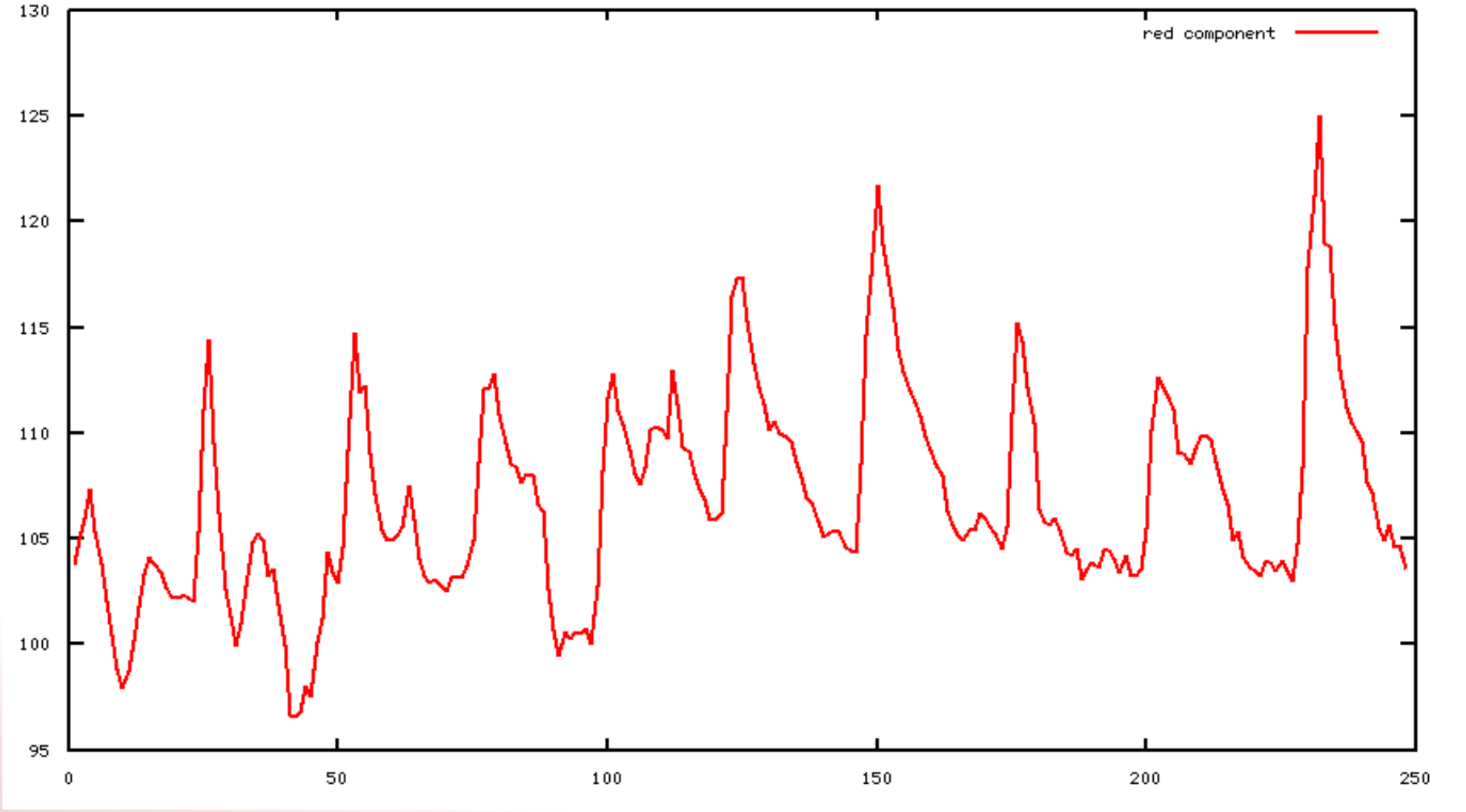
Different height peaks (4/4)



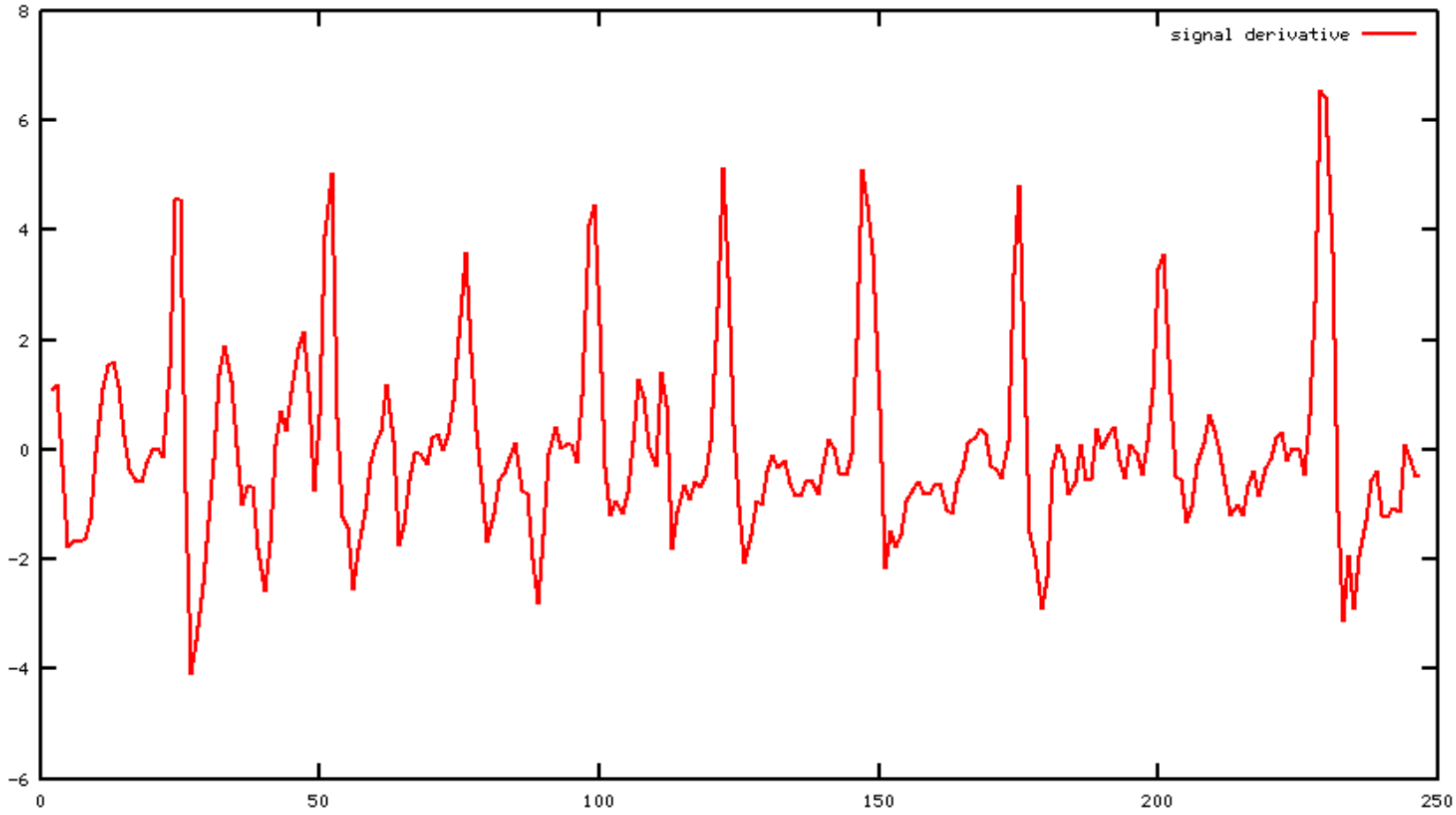
Algorithm steps

1. Signal differentiation
2. Peak detection
3. Choosing appropriate set of peaks
4. Heart rate calculation

Our algorithm in work

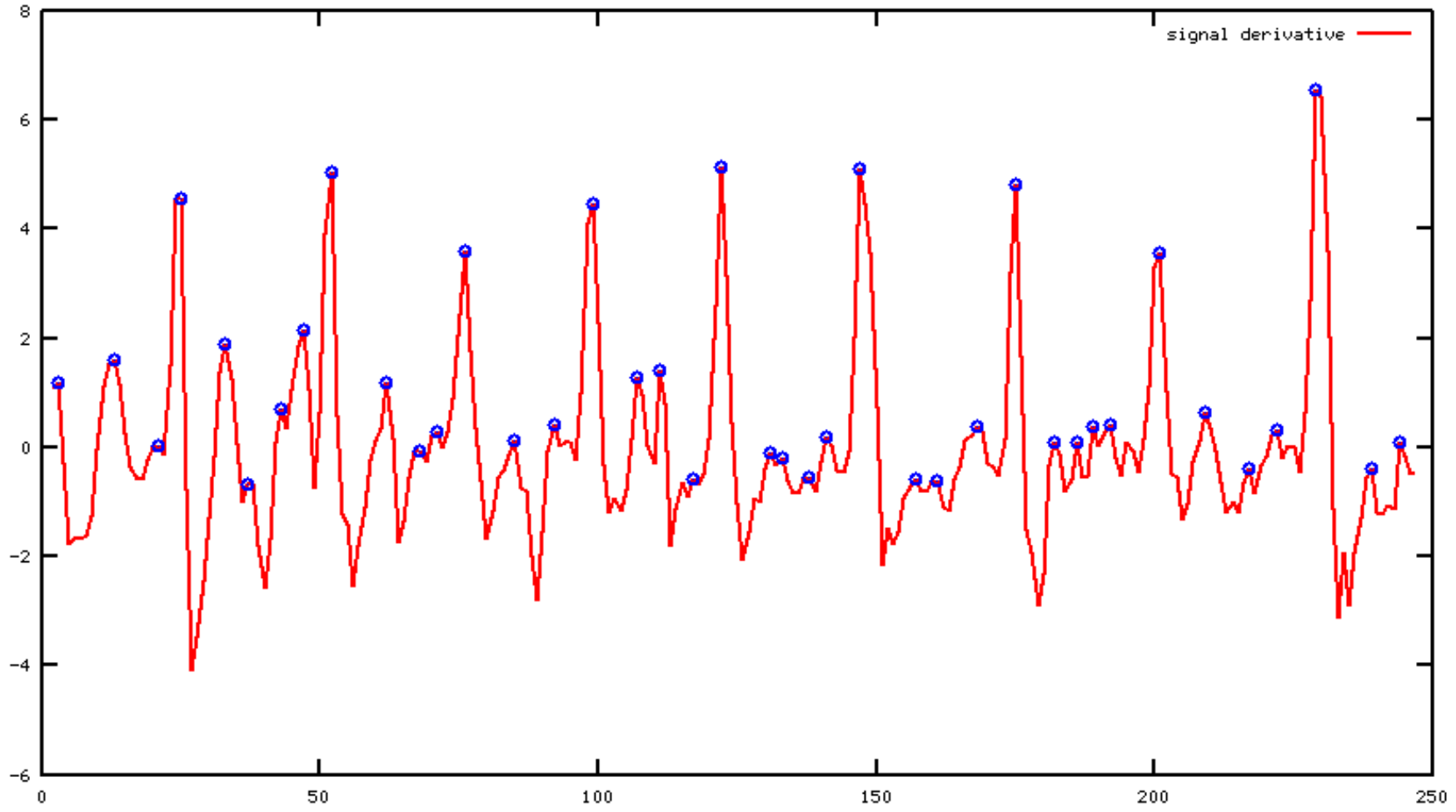


Signal differentiation



Aligns signal baseline and makes signal's average close to zero

Peaks detection



Heart rate calculation

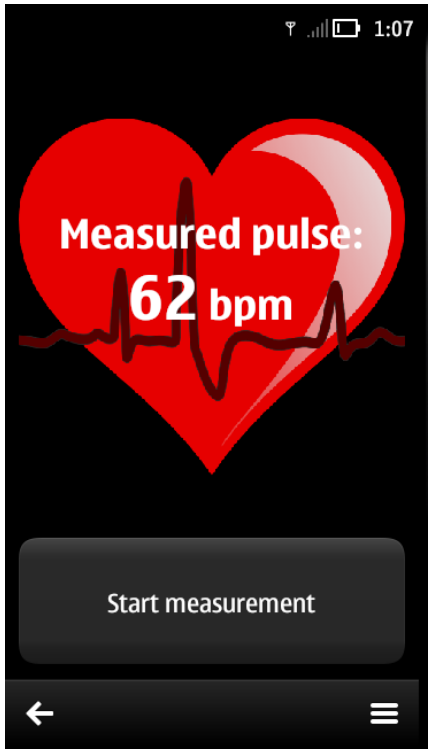
expecting value = 25.5 *frames*

frame rate = 30 *fps*

$$\boldsymbol{heart\ rate = \frac{frame\ rate}{expecting\ value} \times 60}$$

$$\boldsymbol{= \frac{30}{25.5} \times 60 \approx 71\ bpm}$$

Pulse Detector



http://store.ovi.com/content/314173

Thank You!

Q&A

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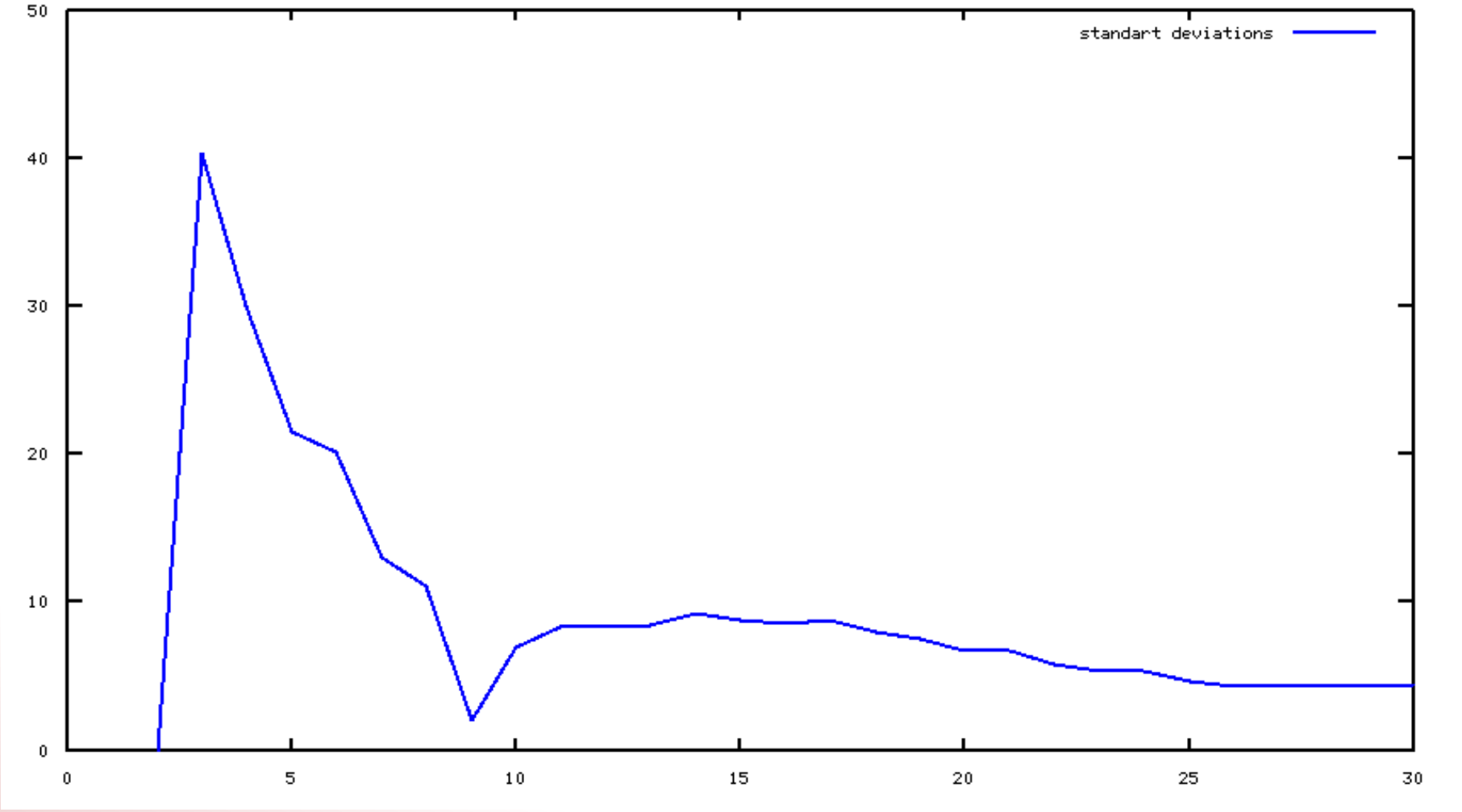
Graph of standard deviations



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Standard deviation counting

n=3; standard deviation=40.305087
n=4; standard deviation=30.049958
n=5; standard deviation=21.546461
n=6; standard deviation=20.191582
n=7; standard deviation=13.084342
n=8; standard deviation=11.126973
n=9; standard deviation=2.070197
n=10; standard deviation=6.964194
n=11; standard deviation=8.342661

...

n=26; standard deviation=4.315476
n=27; standard deviation=4.287370
n=28; standard deviation=4.280080
n=29; standard deviation=4.382958
n=30; standard deviation=4.335101