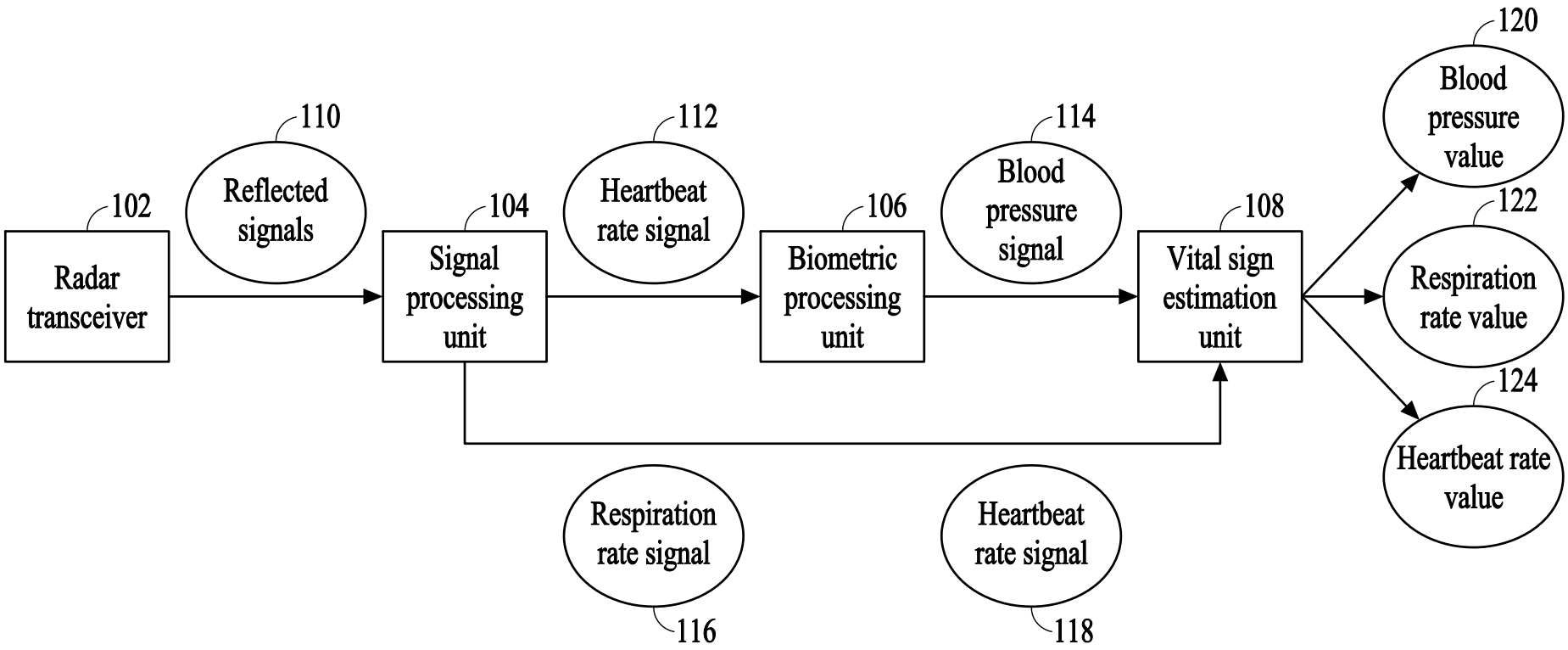
100
102
Radar transceiver
110
Reflected signals
104
Signal processing unit
112
Heartbeat rate signal
106
Biometric processing unit
114
Blood pressure signal
108
Vital sign estimation unit
120
Blood pressure value
122
Respiration rate value
124
Heartbeat rate value
Respiration rate signal
116
Heartbeat rate signal
118

FIG. 1

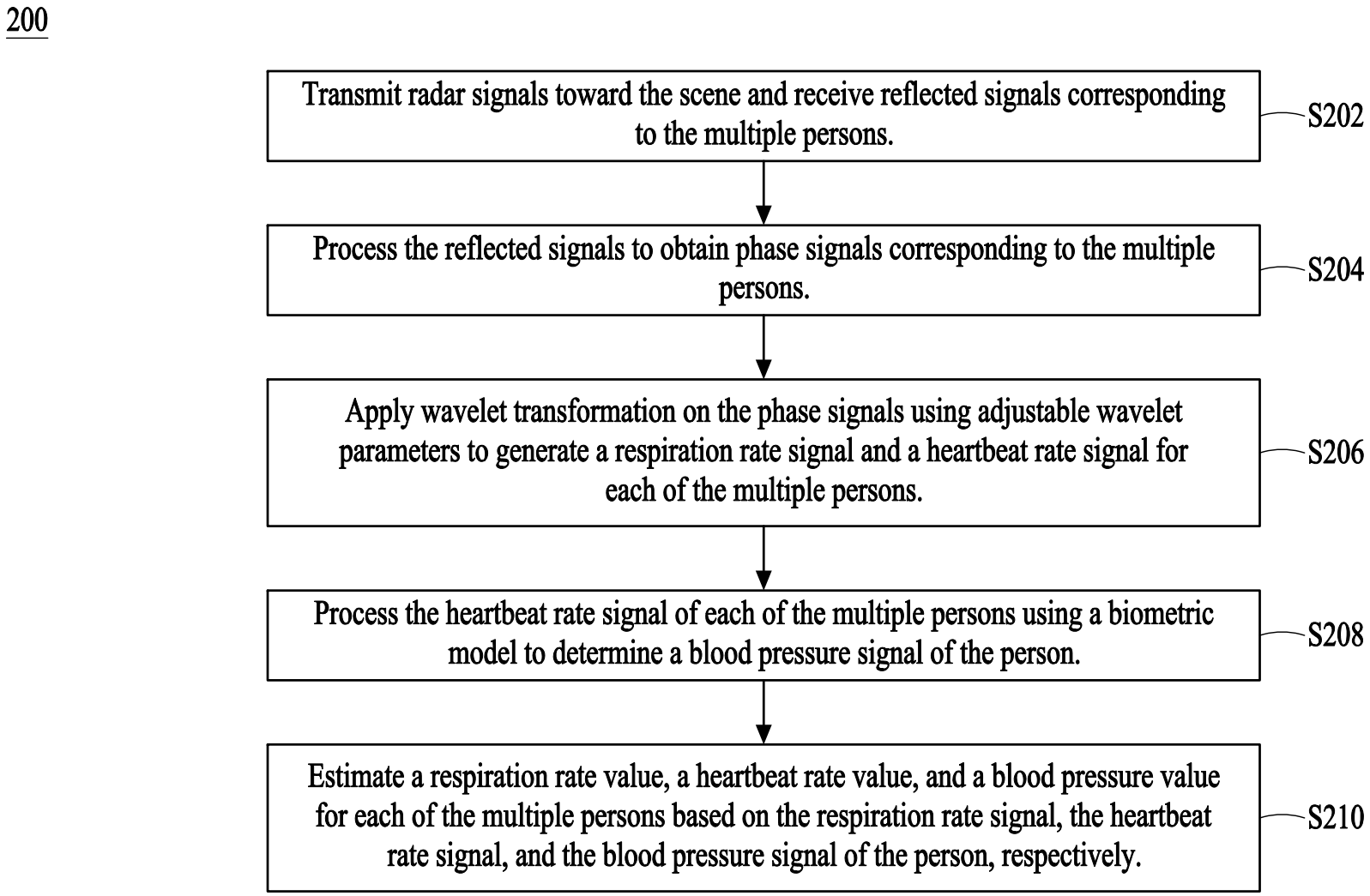
200
Transmit radar signals toward the scene and receive reflected signals corresponding to the multiple persons.
S202
Process the reflected signals to obtain phase signals corresponding to the multiple persons.
S204
Apply wavelet transformation on the phase signals using adjustable wavelet parameters to generate a respiration rate signal and a heartbeat rate signal for each of the multiple persons.
S206
Process the heartbeat rate signal of each of the multiple persons using a biometric model to determine a blood pressure signal of the person.
S208
Estimate a respiration rate value, a heartbeat rate value, and a blood pressure value for each of the multiple persons based on the respiration rate signal, the heartbeat rate signal, and the blood pressure signal of the person, respectively.
S210

FIG. 2

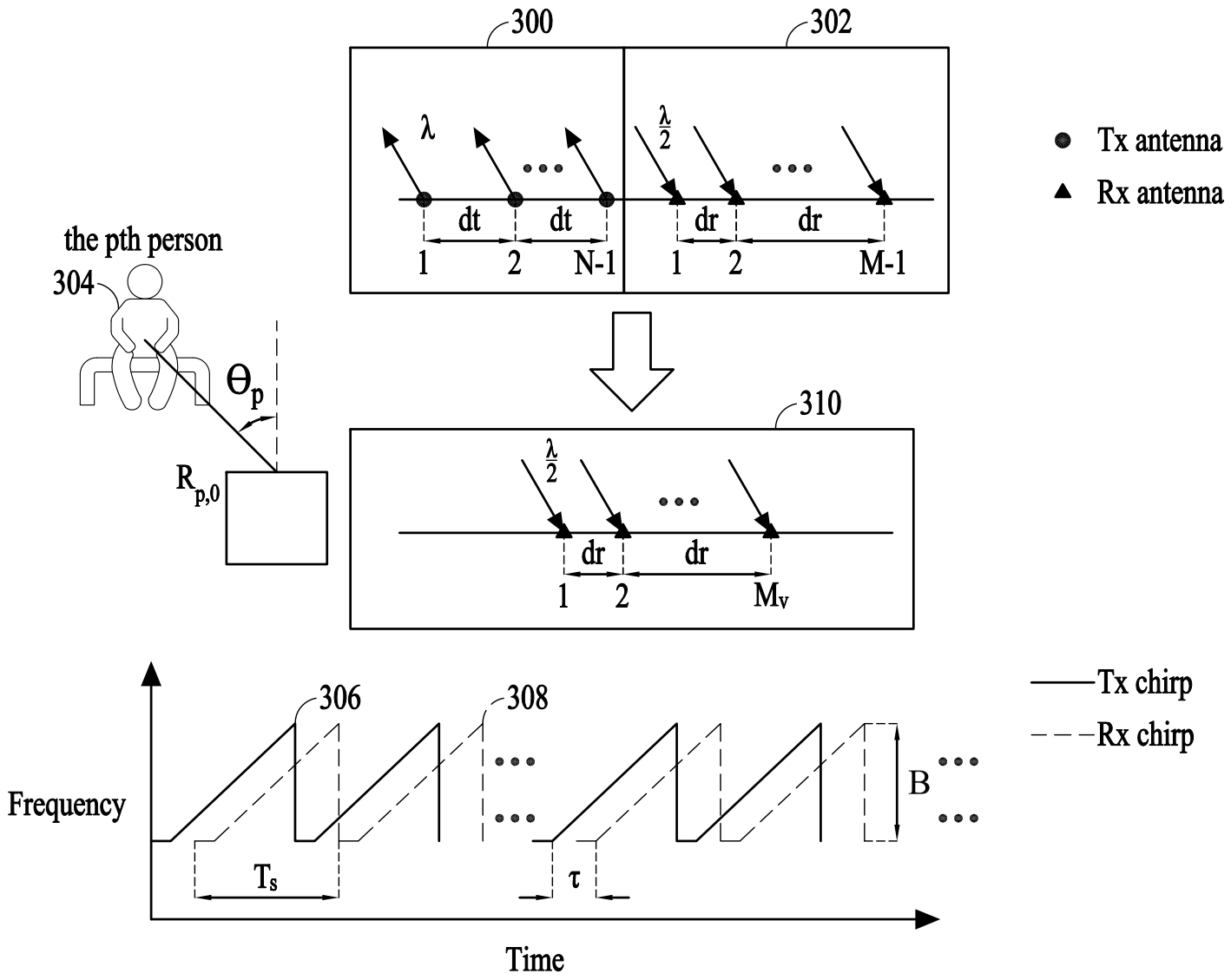
102
300
302
λ
λ/2
dt
dt
dr
dr
1
2
N-1
1
2
M-1
Tx antenna
Rx antenna
the pth person
304
θp
Rp,0
310
λ/2
dr
dr
1
2
Mv
306
308
Tx chirp
Rx chirp
Frequency
B
Ts
τ
Time

FIG. 3

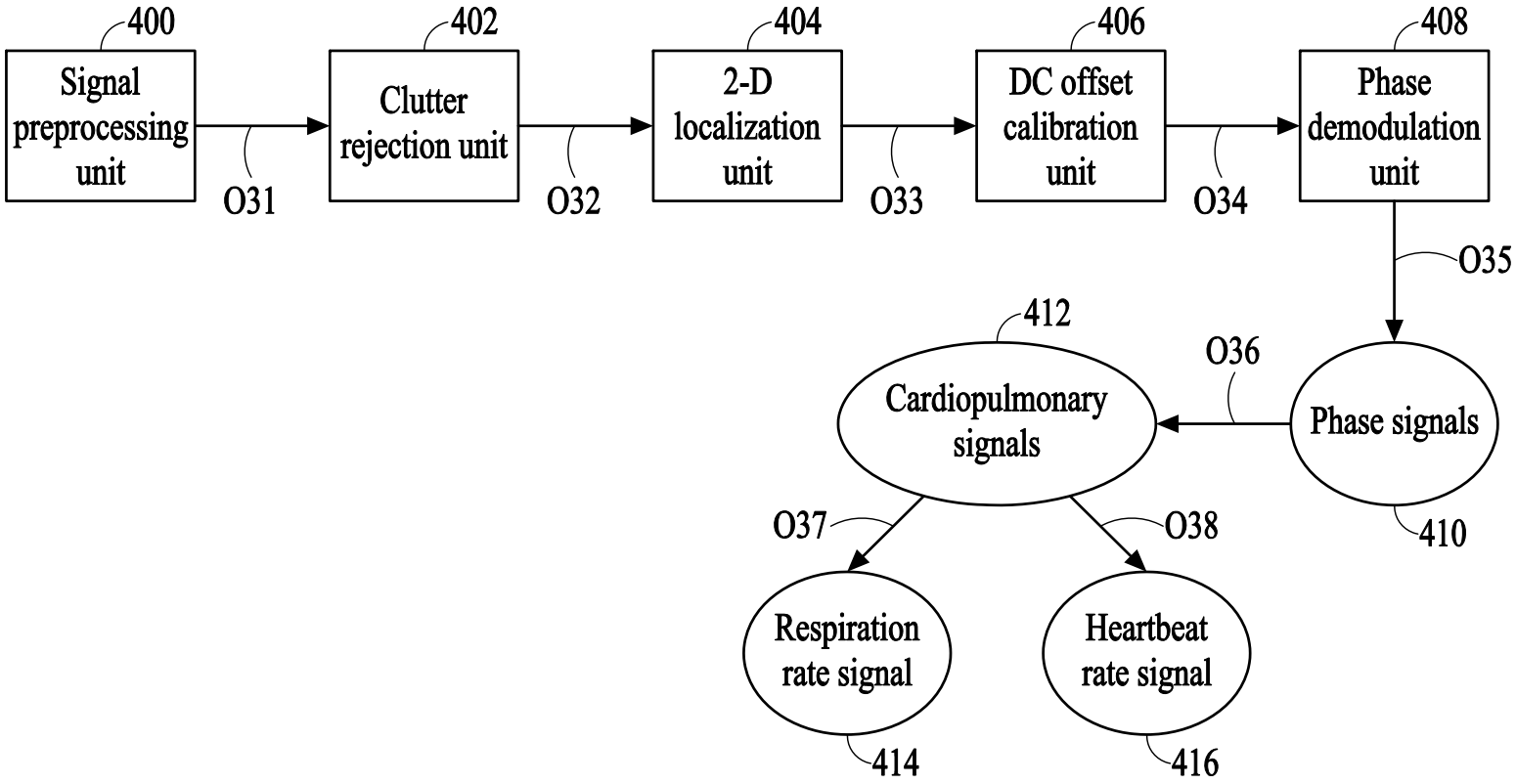
400
Signal preprocessing unit
O31
402
Clutter rejection unit
O32
404
2-D localization unit
O33
406
DC offset calibration unit
O34
408
Phase demodulation unit
O35
412
Cardiopulmonary signals
O36
Phase signals
410
O37
O38
Respiration rate signal
414
Heartbeat rate signal
416

FIG. 4

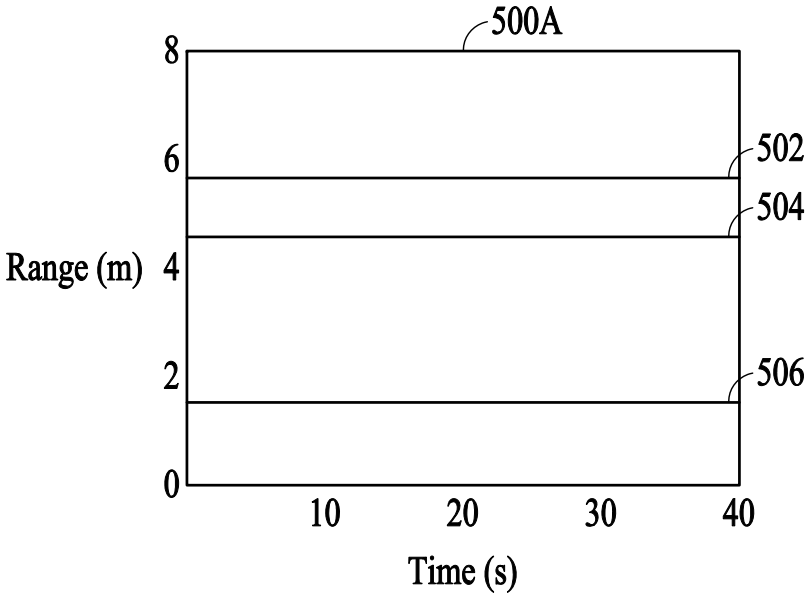
500A
8
6
4
2
0
Range (m)
502
504
506
10
20
30
40
Time (s)

FIG. 5A

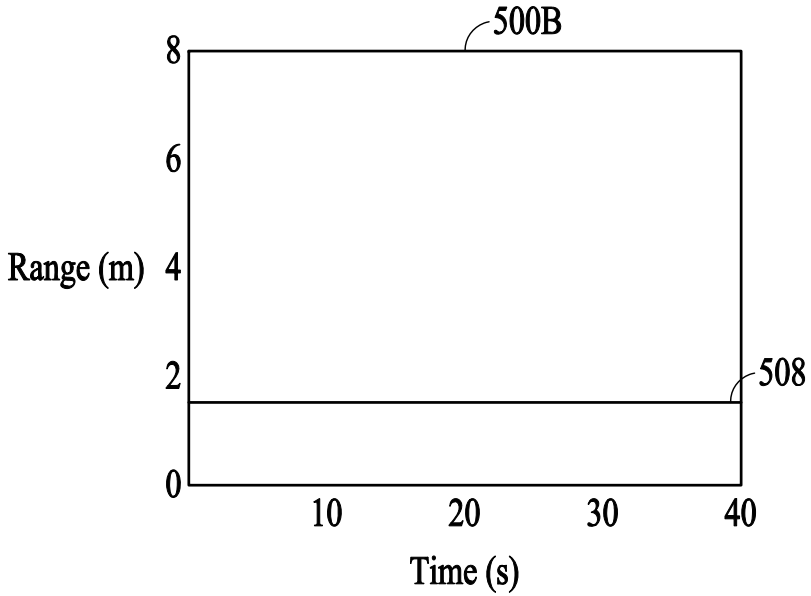
500B
8
6
4
2
0
Range (m)
508
10
20
30
40
Time (s)

FIG. 5B

406

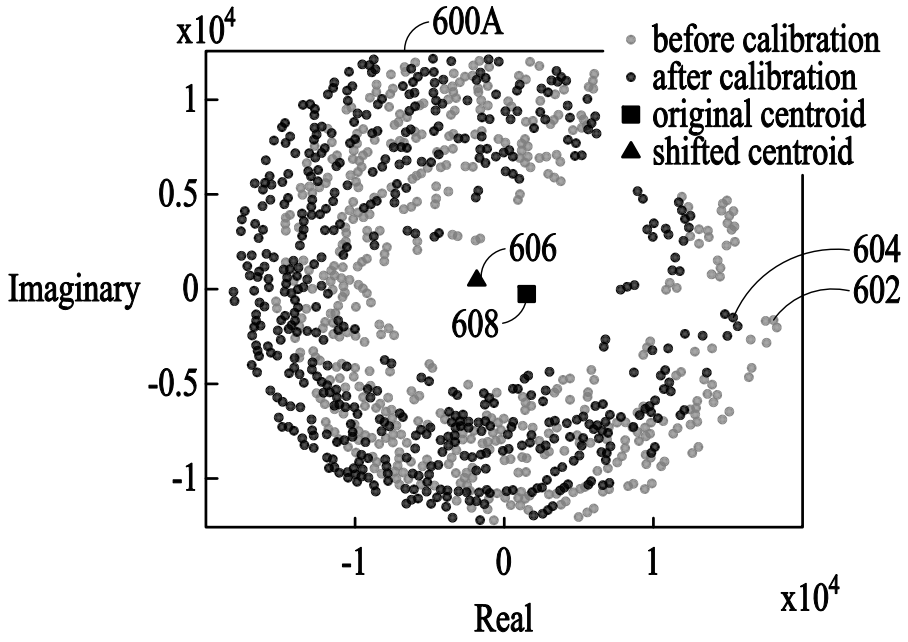

FIG. 6A

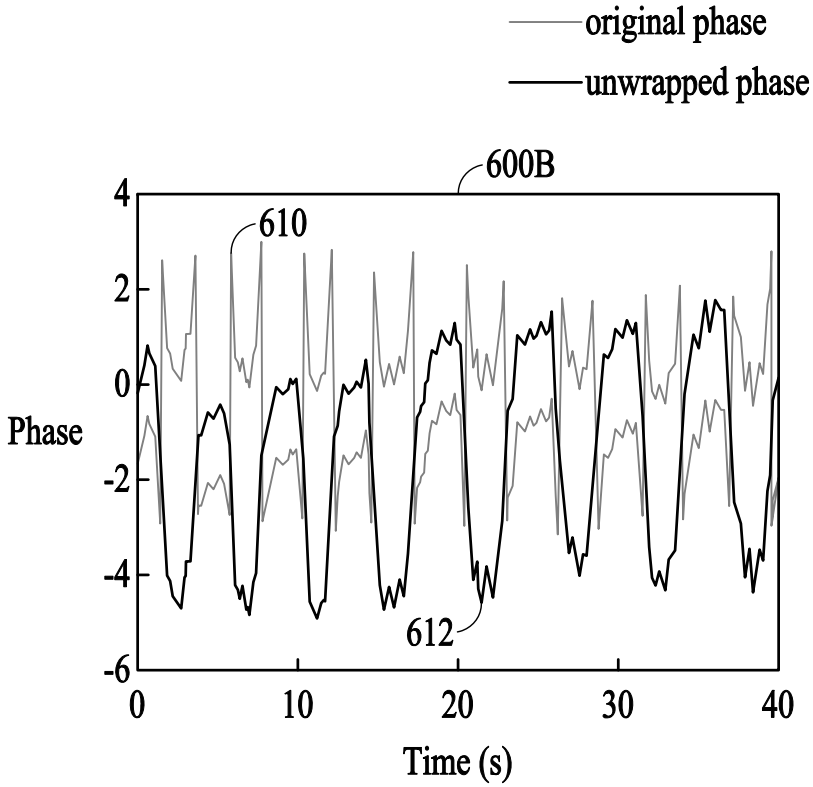

FIG. 6B

700

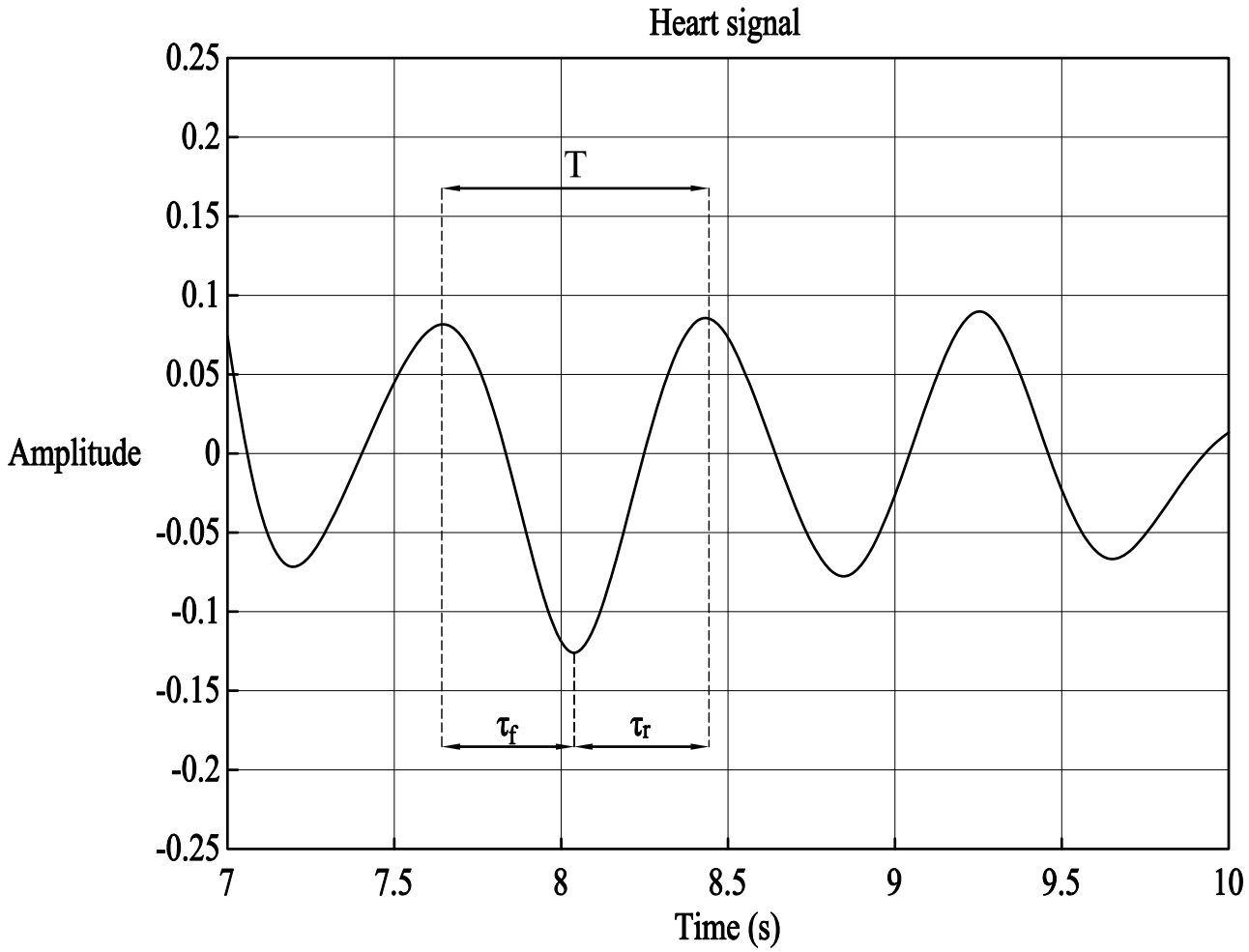
Heart signal
Amplitude
Time (s)
T
τ_f
τ_r
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
7
7.5
8
8.5
9
9.5
10

FIG. 7

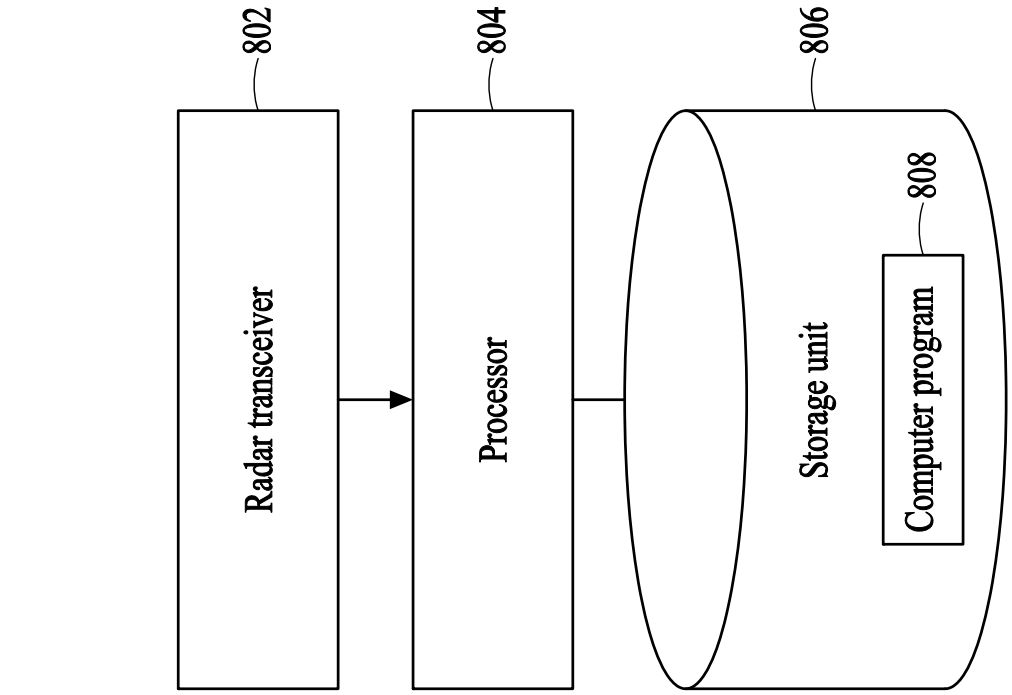
800
802
Radar transceiver
804
Processor
806
Storage unit
808
Computer program

FIG. 8