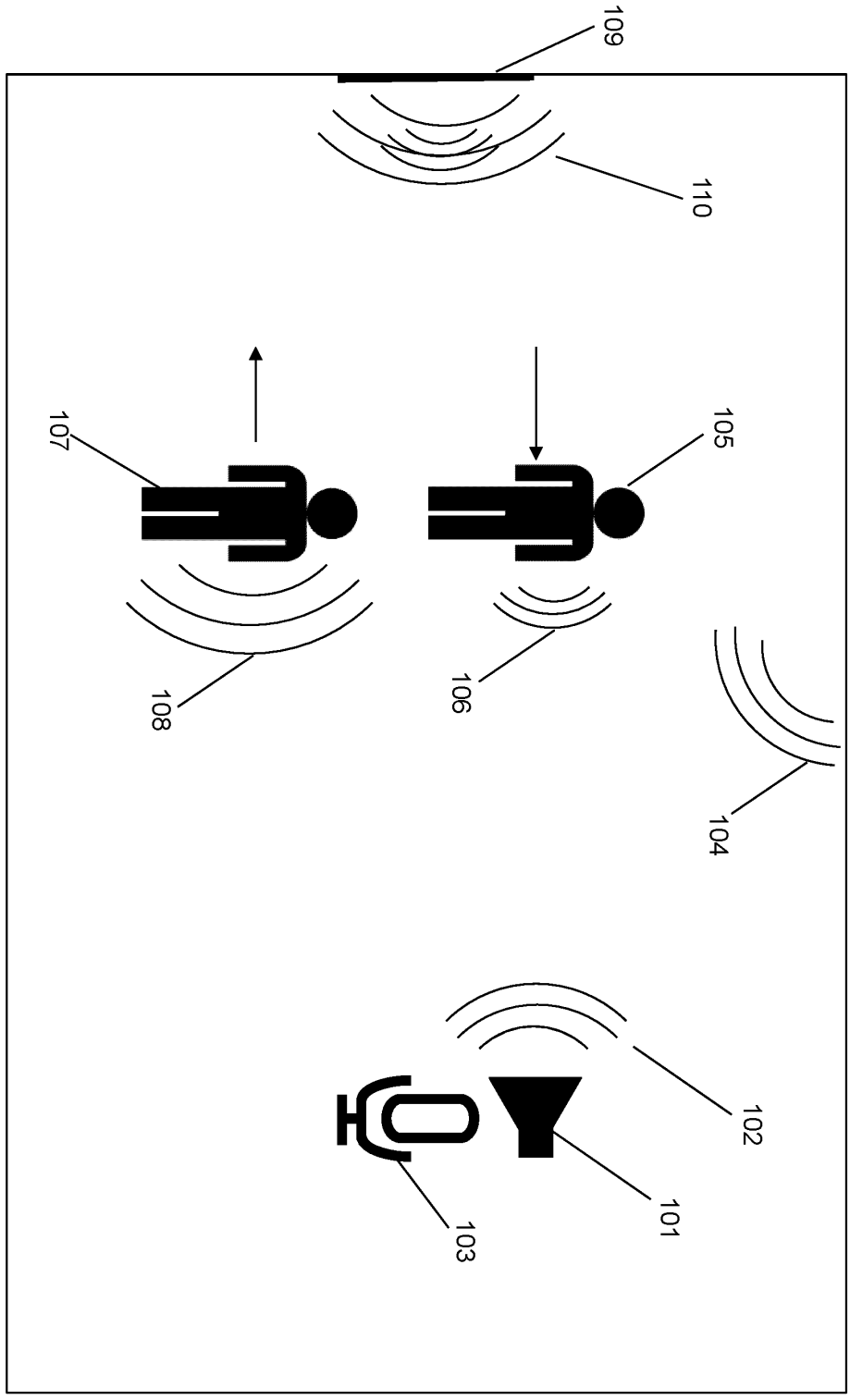


Fig. 1

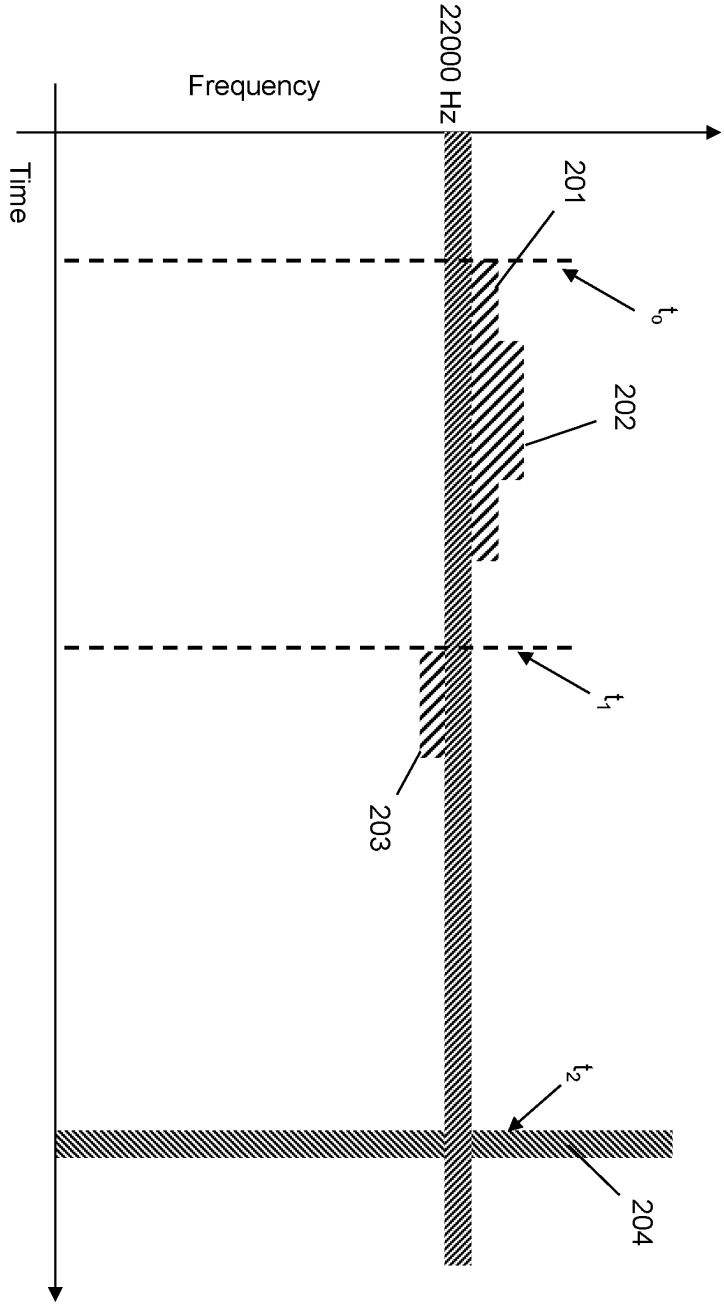


Fig. 2

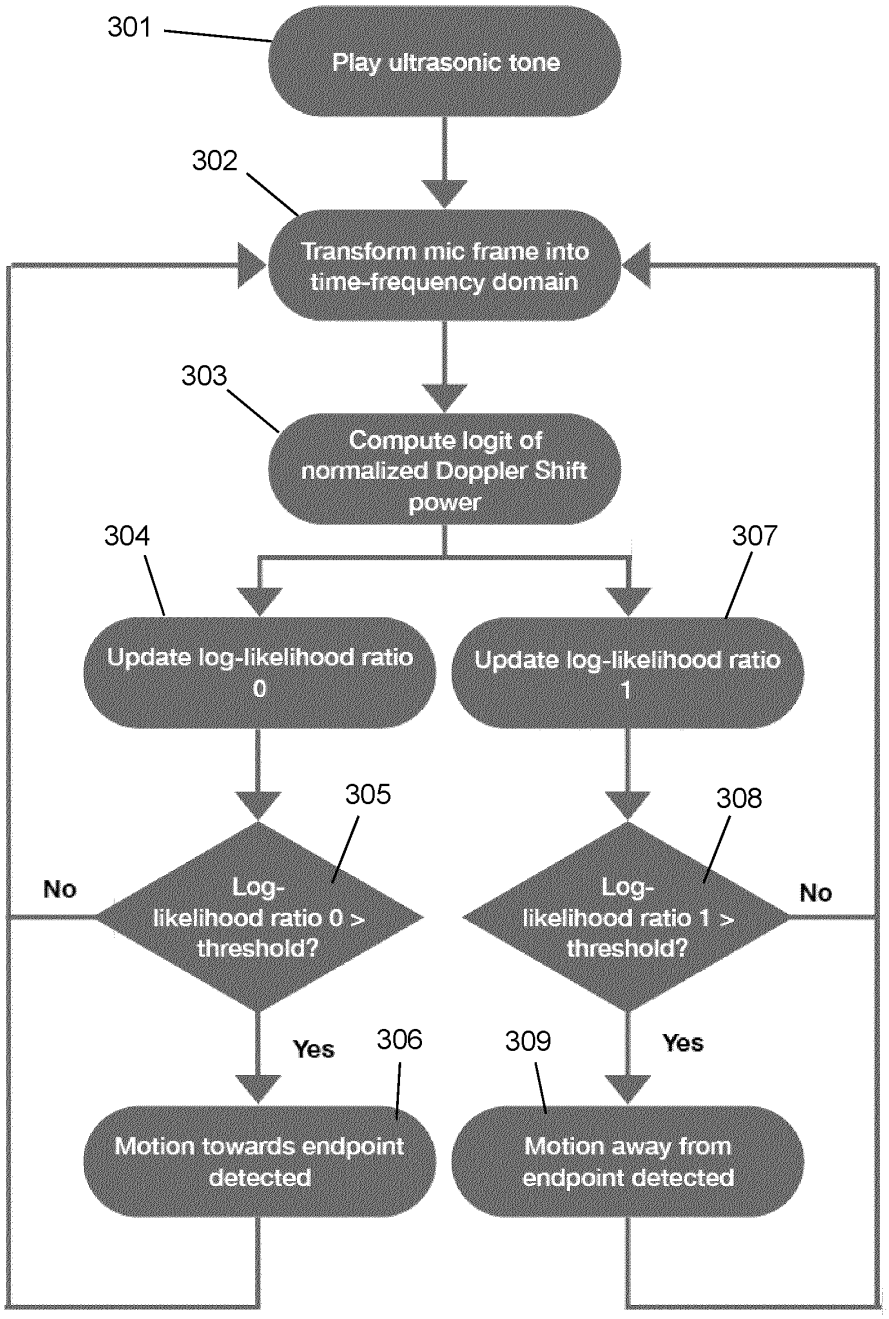

301
Play ultrasonic tone
302
Transform mic frame into time-frequency domain
303
Compute logit of normalized Doppler Shift power
304
307
Update log-likelihood ratio 0
Update log-likelihood ratio 1
305
308
No
Log-likelihood ratio 0 > threshold?
Log-likelihood ratio 1 > threshold?
No
Yes
306
309
Yes
Motion towards endpoint detected
Motion away from endpoint detected

Fig. 3

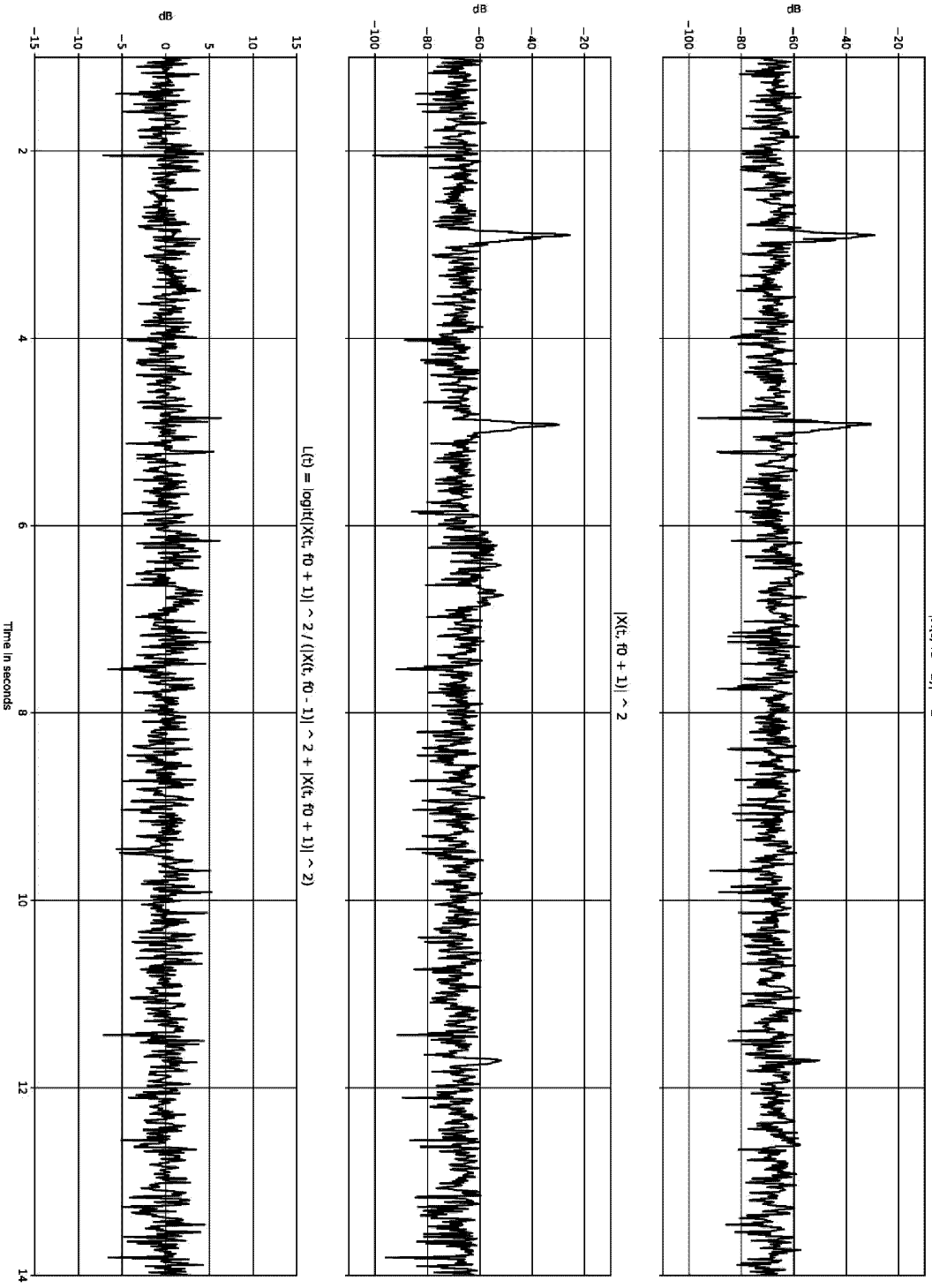

|X(t, f0 - 1)| ^ 2
|X(t, f0 + 1)| ^ 2
L(t) = log[|X(t, f0 + 1)| ^ 2 / (|X(t, f0 - 1)| ^ 2 + |X(t, f0 + 1)| ^ 2)
dB
Time in seconds

Fig. 4

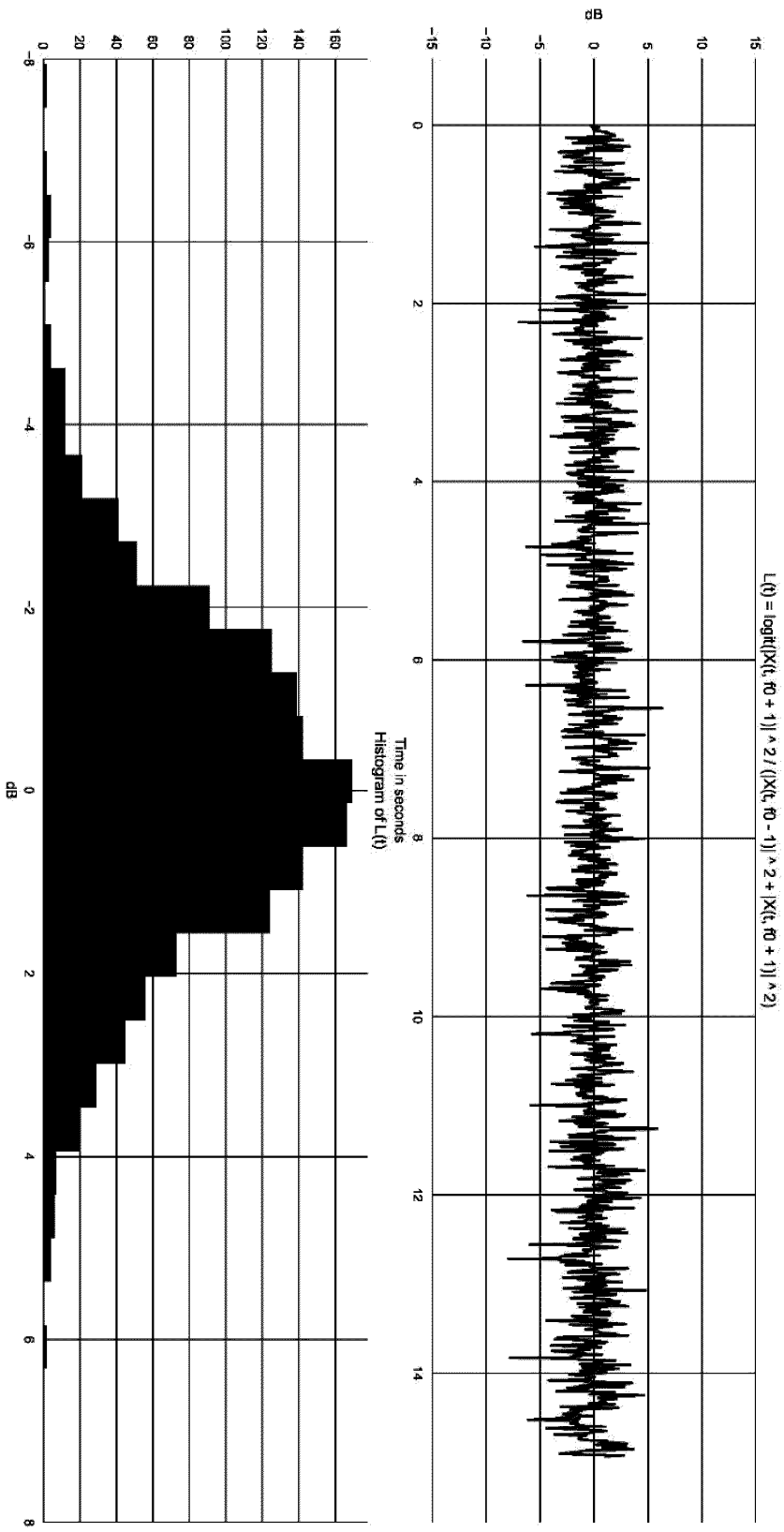

dB
L(t) = logit(|X(t, f0 + 1)| ^ 2 / (|X(t, f0 - 1)| ^ 2 + |X(t, f0 + 1)| ^ 2))
Time in seconds
Histogram of L(t)
dB

Fig. 5

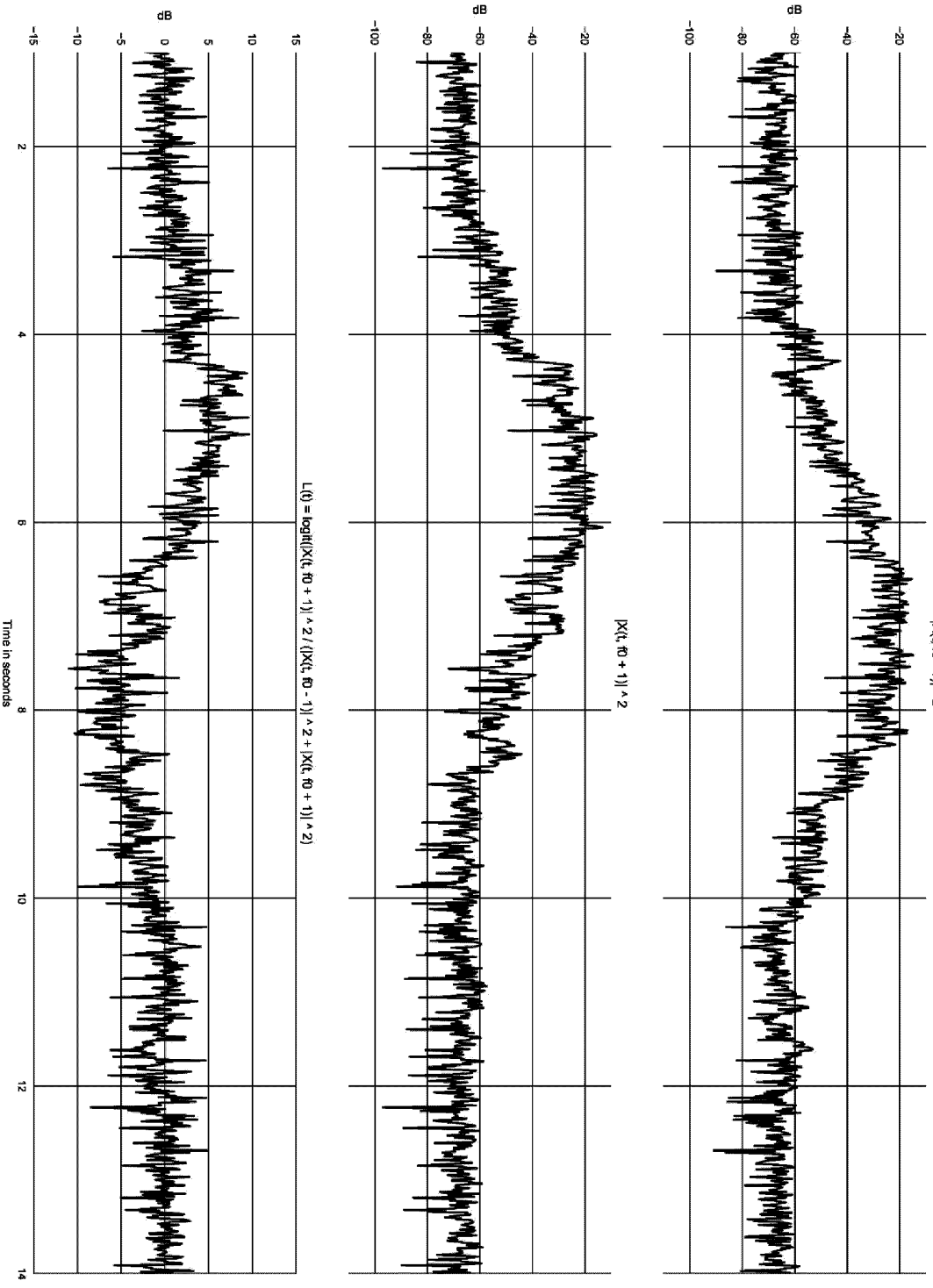

dB
|X(t, f0 - 1)| ^ 2
|X(t, f0 + 1)| ^ 2
L(t) = logit(|X(t, f0 + 1)| ^ 2 / (|X(t, f0 - 1)| ^ 2 + |X(t, f0 + 1)| ^ 2))
Time in seconds

Fig. 6

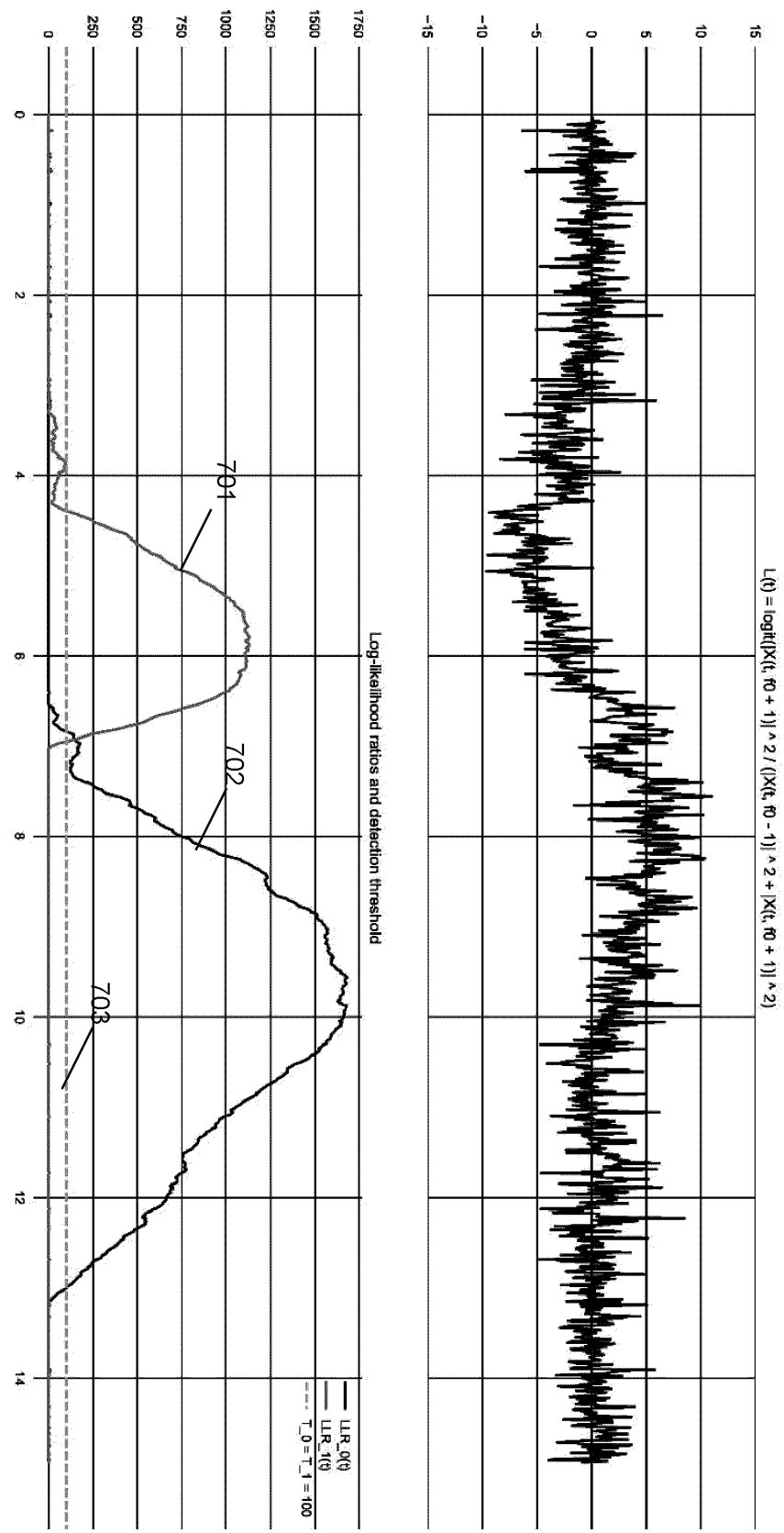

L(t) = log|(|X(t, f0 + 1)| ^ 2 / (|X(t, f0 - 1)| ^ 2 + |X(t, f0 + 1)| ^ 2)
Log-likelihood ratios and detection threshold
LLR_0(t)
LLR_1(t)
T_0 = T_1 = 100
701
702
703

Fig. 7

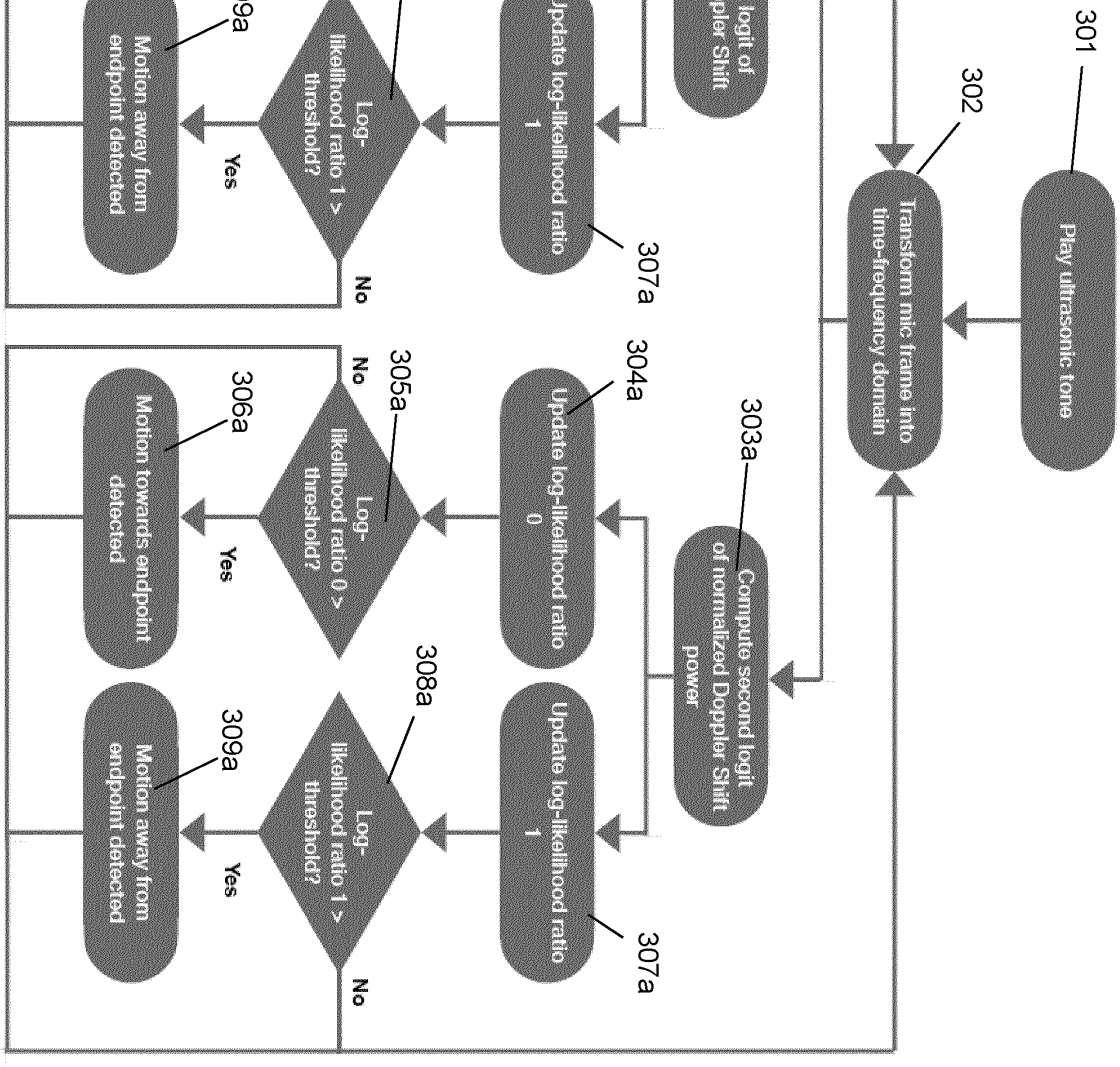

301
Play ultrasonic tone
302
Transform mic frame into time-frequency domain
303a
Compute first logit of normalized Doppler Shift power
303a
Compute second logit of normalized Doppler Shift power
304a
Update log-likelihood ratio 0
304a
Update log-likelihood ratio 0
305a
Log-likelihood ratio 0 > threshold?
No
Yes
305a
Log-likelihood ratio 0 > threshold?
No
Yes
306a
Motion towards endpoint detected
306a
Motion towards endpoint detected
307a
Update log-likelihood ratio 1
307a
Update log-likelihood ratio 1
308a
Log-likelihood ratio 1 > threshold?
No
Yes
308a
Log-likelihood ratio 1 > threshold?
No
Yes
309a
Motion away from endpoint detected
309a
Motion away from endpoint detected

Fig. 8