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2001 - 0067091
2001 07 12

(21) 10 - 2000 - 0048514
(22) 2000 08 22

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09/432,061 1999 11 02 (US)

(71) 3191 45 141 195

(72) 가 7024 13
- 3960 1
- 7030 74
7014 7

(74)
:

(54)

가 , ECG
R . ,
dr
(,)

()가 , , , /
 2 가
 .가
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 2 가 .
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5 가

6 가

7 r, u, v w ,

8

r , V_v, V_w V_r ,

9

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12

13

140 : 142 :

144 : 146 :

148 : 149 :

150 : 152 :

154 :

(tissue deformation)

(strain)

가

"(strain)"

2

(segment)

가

(cardiology)

(apical view)

. M -

2D

가 .

(noninvasive electrophysiology)

AV -

(- - (Wolf - Parkinson - White))

가 (catheter)

M -

가 .1 , L₀ 가 L

1

$$\varepsilon = \frac{L - L_0}{L_0}$$

1 (dimensionless description) . L

2

$$\dot{\varepsilon} = \frac{\partial \varepsilon}{\partial t}$$

가 , 가 3 .

3

$$\dot{\varepsilon} = \frac{\partial v}{\partial r}$$

$L(t) = |r_2(t) - r_1(t)|$ $L_0 = |L(t_0)|$
 r_1 r_2 $t > t_0$ $r_0 \rightarrow r_2$
 deformation), (rate - of -

2D 가 (anomalies) 가

(RF) M - 1997 IEEE Trans. on Ultrasonics, Ferroelectrics and Frequency Control, vol. 44, pp.752 - 768 " Noninvasive evaluation of local myocardial thickening and its color - coded imaging" 가 ,가 M - 2 (robustness)

1998 10 7 , " A METHOD AND APPARATUS FOR PROVIDING REAL - TIME CALCULATION AND DISPLAY OF STRAIN IN ULTRASOUND IMAGING" 09/167,896 가 (color Doppler) 가 (multi line acquisition:MLA) 가 가 가 (T) 4

4 $t_{D0} = N_b NT$

N , N_b

MLA , .
 1 - , 5 가
 . MLA

5

$$t_{DMLA} = \frac{N_b}{N_{MLA}} NT$$

N_{MLA}

T 1

가 T , $T_0 = 2d/c$, $T = N_{int} T_0$
 , T_0 가

가 가

N_{int}

6

6

$$t_{Dint} = \frac{N_b}{N_{int} N_{MLA}} NT$$

1
 1 N_b 8 , N_{int} 2 (100) , N_{int}
 8 , (110) , N_{int} 4 , (120) N_{int} 1

가 2 , 2 , N 3

N_{int} N_b . T
 , t_F

, t_T t_D

(130)

PRF

N

(132, 134, 136)

N (132, 134, 136)

7

7

$$t_F = t_T + \frac{N_b}{N_{MLA}} NT$$

t_T

1 2 . 2 ()
 8)

PRF

2

(Nyquist limit)

가

가

PRF

가

가

가

(sliding window technique)

, ECG R -

dr

dr ()

()가 (unity temporal lag)

2 -

가

가 . 가

가

가

가

2

2

가

/

가

가 , 가 /

(144) 가 3 (140)

(142) (echoes) (146)

(146) (148) (149)

(148) I, Q I, Q

(150) /

(149) B -

2D 3D

(150) /

(149) (152)

(152) (154)

1998 10 7 , " A METHOD AND APPARATUS FOR PROVIDING REAL - TIME CALCULATION AND DISPLAY OF STRAIN IN ULTRASOUND IMAGING"

09/167,869 3

(PRF)가 가 (SRI)

가 2

가 가 가

가 4 가 N="3"

SRI 4

$N_{int} = N_b \cdot T$, t_T t_D

, t_F SRI 4

N ((160, 161, 162, 163, 164))

SRI

8

8

$$t_{FSRI} = t_T$$

가 7 8

(150) 가

가 L(t) s(t) 1

" (strain rate)"

9

9

$$v(t, r) = s(t)r$$

r = "0" 0 , 가, v(t,0)가 0

t 10 .

10

$$L(t + \Delta t) - L(t) \approx \Delta t s(t)L(t)$$

t 0 , 11 .

11

$$\frac{dL(t)}{dt} = \lim_{\Delta t \rightarrow 0} \frac{L(t + \Delta t) - L(t)}{\Delta t} = s(t)L(t)$$

12 .

12

$$L(t) = L_0 \exp\left(\int_0^t s(\tau) d\tau\right)$$

13 .

13

$$e(t) = \frac{L(t) - L_0}{L_0} \cdot 100\% = [\exp\left(\int_0^t s(\tau) d\tau\right) - 1] \cdot 100\%$$

14 . e(i) 13

14

$$e(i) = [\exp(C(i)) - 1] \cdot 100\%,$$

$$C(i) = C(i-1) + s(i)\Delta t$$

i , t . C(i) , s(i) , C(i-1)
 , ECG -
 I 0
 , 가
 (TVI) SRI .

v가 , 가 , 가 . m₀

15

$$d = v\Delta tk_s$$

v m₀ , k_s ,
16 m₀ .

16

$$m = m_0 + d$$

09/167,869

가

17

17

$$s(r) = (v(r + dr) - v(r)) / dr$$

r , v , dr .
가 . dr ,

가 가 가
가 가 가
09/167,869)가 (dr

(150)

가 . m , n
x(m, n) . f₀, T,
가 M r_s N 가 . c
18

18

$$s = \frac{c}{4\pi f_0 T r_s} \frac{\sum_{m=1}^{M-1} a_m |\hat{s}(m)| \hat{\omega}_s(m)}{\sum_{m=1}^{M-1} a_m |\hat{s}(m)|}$$

19

19

$$S(m) = \frac{1}{M-m} \sum_{k=1}^{M-m} \hat{R}^*(k) \hat{R}(k+m)$$

20

20

$$\hat{\omega}_s(m) = \frac{1}{m} \angle \hat{S}(m)$$

21

21

$$a_m = m^2 \left(1 - \frac{m}{M} \right)$$

가 . $\hat{R}(m)$.

18 , 1994 " Myocardial velocity gradients detected by Doppler imaging" B r.J.Radiol., 67(799):679 - 688 (D.Flemming) , 1995 " Myocardial velocity gradient as a new indicator of regional left ventricular contraction:Detection by a two - dimensional tissue Doppler imaging technique" J.Am.Col. Cardiol, 26(1):217 - 23 (Uematsu)

Myocardial Velocity Gradient(MFG)

()

(least squares linear regres

sion) . 가 . , 18 가
19 가 ,

5 6 18 () (fit)(
가) 가 . 5 () 가 1.0 s^{-1} , 가
가 5 . ()) 가
() 50 () . 가
가 , 가 1.0 s^{-1} () . 가

22 $\hat{R}(m)$ (19) . ,

22

$$\hat{R}(m) = \sum_{n=1}^{N-1} x^*(m, n)x(m, n+1)$$

22 $\hat{R}(m)$ $\hat{R}(m)$

$\hat{R}(m)$ m m+ m 23 m

23

$$\hat{R}(m) = \sum_{n=1}^{N-1} x^*(m, n)x(m + \Delta m, n+1)$$

m $\hat{R}(m)$ m 가 1998
 " Time - efficient and exact algorithms for adaptive temporal stretching and 2D - correlation for elastographic imaging using phase information" (A.Peasvento) (H.Ermert)
 $\hat{R}(m)$ 가 m

24

$$\Delta m = \frac{v}{PRF} k_s$$

v , PRF , k_s
 가 가
 (150)
 가 , f₁ f₂ f₃ 2
 22 , f₃
 $\hat{R}_3(m)$ 25 $\hat{R}_1(m), \hat{R}_2(m) \hat{R}_3(m)$

25

$$v_3 = \frac{cPRF}{4\pi f_3} \angle \hat{R}_3(m)$$

c 25
 26

26

$$\hat{R}_d(m) = \hat{R}_1^*(m) \hat{R}_2(m)$$

27

27

$$v_d = \frac{cPRF}{4\pi(f_2 - f_1)} \angle \hat{R}_d(m)$$

27 c

$$\hat{R}_1(m) \hat{R}_2(m) \quad (f_2 - f_1) \quad f_3$$

1992 "Two years experience in measuring velocities beyond the Nyquist limit with Color Flow Mapper" Proceeding of EURODOP'92, page 219, Brighton, United Kingdom (Dousse)

25

v_3

가

28

()

28

$$v_{3,k} = \frac{cPRF}{4\pi f_3} (\angle \hat{R}_3(m) + 2k\pi) - \left[\frac{f_3 - (f_2 - f_1)}{2(f_2 - f_1)} \right] < k < \left[\frac{f_3 - (f_2 - f_1)}{2(f_2 - f_1)} \right]$$

, ()

v_3

가

$v_{3,k}$ 가

가

v_d 가

7

가

r - ,

l - (),

u - ,

v - (),

w - ,

u, v w 7

w (u, v, w) = (0, 0, 0)

S_r, S_l, S_u, S_v, S_w

가

, $v = r$, $w = 0$, $v - w = (r, 0)$, $(v, w) = (r, 0)$ 가

$(v, w) = (0, 0)$ 가 $(v, w) = (r, 0)$ 29 30

29 $v_v = v s_v$

30 $v_w = w s_w$

8 v_v, v_w, v_r 가 v_v, v_w, v_r 가 (v, w) 31

31 $v_r = v s_v \cos \alpha + w s_w \sin \alpha$

v_r r $v w$ $(r - l/2)$ 32

32 $v = r \cos \alpha + l \sin \alpha$
 $w = r \sin \alpha - l \cos \alpha$

31 33 $v_r = s_v (r \cos \alpha + l \sin \alpha) \cos \alpha + s_w (r \sin \alpha - l \cos \alpha) \sin \alpha$

r l 34가

34 $\frac{\partial v_r}{\partial r} = s_v \cos^2 \alpha + s_w \sin^2 \alpha$
 $\frac{\partial v_r}{\partial l} = s_v \sin \alpha \cos \alpha - s_w \sin \alpha \cos \alpha$

s_v s_w , 35 .

35

$$s_v = \frac{\partial v_r}{\partial r} + \frac{\partial v_t}{\partial t} \tan \alpha$$

$$s_w = \frac{\partial v_r}{\partial r} - \frac{\partial v_t}{\partial t} \cot \alpha$$

, $v()$ $w()$ 가 l_r v_w (parasternal long axis view:PLAX) .

v u , l_r u_w , u () (short axis view:SAX) .

, w 가 \cot 가 u v \tan 가

SAX X 가 , 36 가 SA

36

$$\alpha = \frac{3\pi}{2} - \theta_b + \theta_c$$

b ($b = "0"$) , c 가

2 1 가 . 3 가 (

, 2 10 , 12 6 \cot \tan 가 가

3 . 가

x - ()

y - ()

z -

u - ,

v - (),

w - ,

3 x, y, z u, v, w 가 .
 s_u, s_v, s_w . $(u, v, w) = (0, 0, 0)$

, $(u, v, w) = (0, 0, 0)$ 가 .
 r , (u, v, w) 37

37

$$v_u = us_u, \quad v_v = vs_v, \quad v_w = ws_w$$

가 .

uvw - xyz . z ()
 38 . 3

38

$$v_{zr} = \frac{\partial v_z}{\partial r}, \quad r = x, y, z$$

uvw 39 .

39

$$\begin{bmatrix} v_{xx} \\ v_{yy} \\ v_{zz} \end{bmatrix} = \mathbf{A}(\alpha, \beta, \gamma) \begin{bmatrix} s_u \\ s_v \\ s_w \end{bmatrix}$$

$\mathbf{A}(\alpha, \beta, \gamma)$ uvw xyz 3D , , , u , v , w

40 .

40

$$\begin{bmatrix} s_u \\ s_v \\ s_w \end{bmatrix} = \mathbf{A}^{-1}(\alpha, \beta, \gamma) \begin{bmatrix} v_{xx} \\ v_{yy} \\ v_{zz} \end{bmatrix}$$

uvw 41 .

41

$$\hat{v}_{zr} = \frac{v_z(r + \Delta r) - v_z(r)}{\Delta r}, \quad r = x, y, z$$

x, y, z , . 1D

x y . 가 가 (42)

42

$$s_u + s_v + s_w = 0$$

2) uw () 43 , vw - (44

43

$$s_u = v_{zz} + v_{zy} \cot \beta$$

$$s_w = v_{zz} + v_{zy} \tan \beta$$

44

$$s_v = v_{zz} + v_{zy} \cot \alpha$$

$$s_w = v_{zz} + v_{zy} \tan \alpha$$

, w cot가 가 가 . u v tan가

가 , , 4 () , () 가 (- -) (, (cineloops))

, 가 , 가 가 , 16 ASE 가 (2 , 4 , lax, sa x,) 가

, 가 가 .

9 . (200), (202) (204)
. ECG (206) .

. 가 가 . 가 가
. 가 가

10 (210), (212) (214)
9 10 11 (230), (2
32) (234) , 12 (2
240), (242) (244)
. 11 12

가 , .

13 가
. 13 가 (250) (2
52)

LV . 13 - (Bulls - eye)

가 .

(57)

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2 3

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3 4

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(a linear regression)

7.

4 ,

1 2

1 2

8.

4 ,

$$S(r) = \text{conj}(R(r)) * R(r+dr)$$

$$R(r) ,$$

$$S(r) ,$$

$$SV(r) = c / (4 \pi r T f_0) \text{phase}(S(r))$$

9.

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S(r)

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 1 , 2 3 ,
 , 1 , 2 1 f₁
 , 3 2 f₂
 , , 3 f₃

1 , 2

3 , (f₃ - (f₂ - f₁))/(2(f₂ - f₁)) 가

1 가

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, 1 , 2 f_1 f_2 ,

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f_2 f_1 , 1

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f_3 3 3

3 3 ,

f_3 , $(f_3 - (f_2 - f_1))/(2(f_2 - f_1))$ 가

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(monotonic map)

63.

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64.

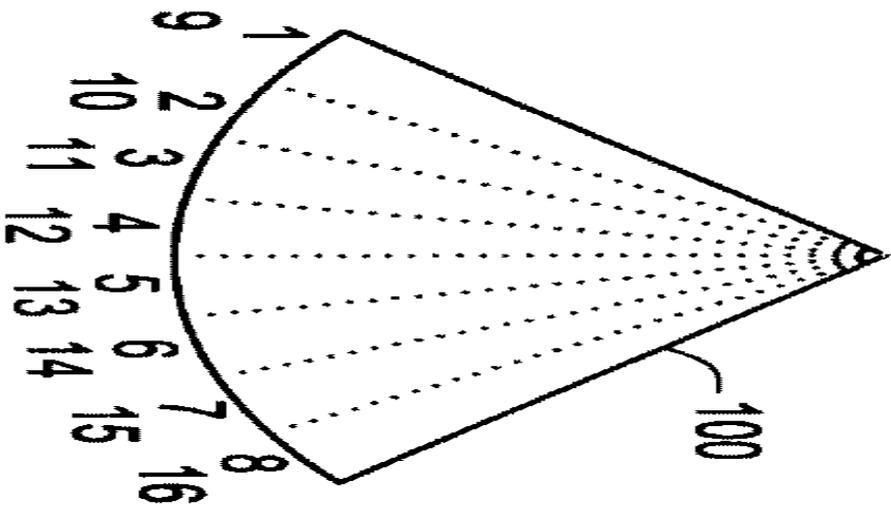
60

,

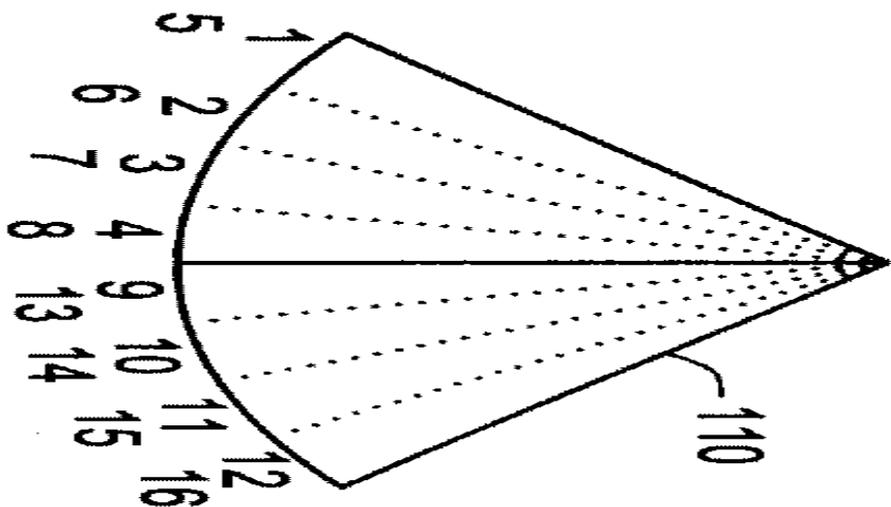
,

(종래기술)

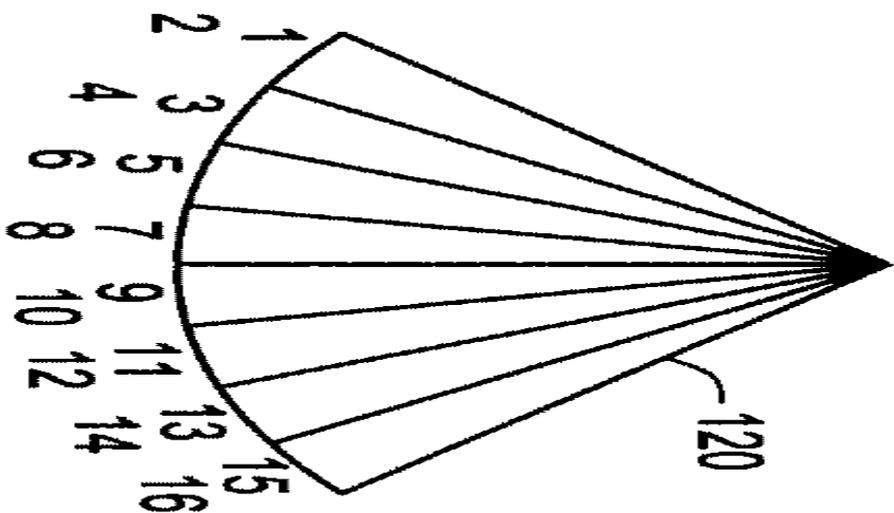
$$N_{int} = N_b$$



$$N_{int} = N_b/2$$

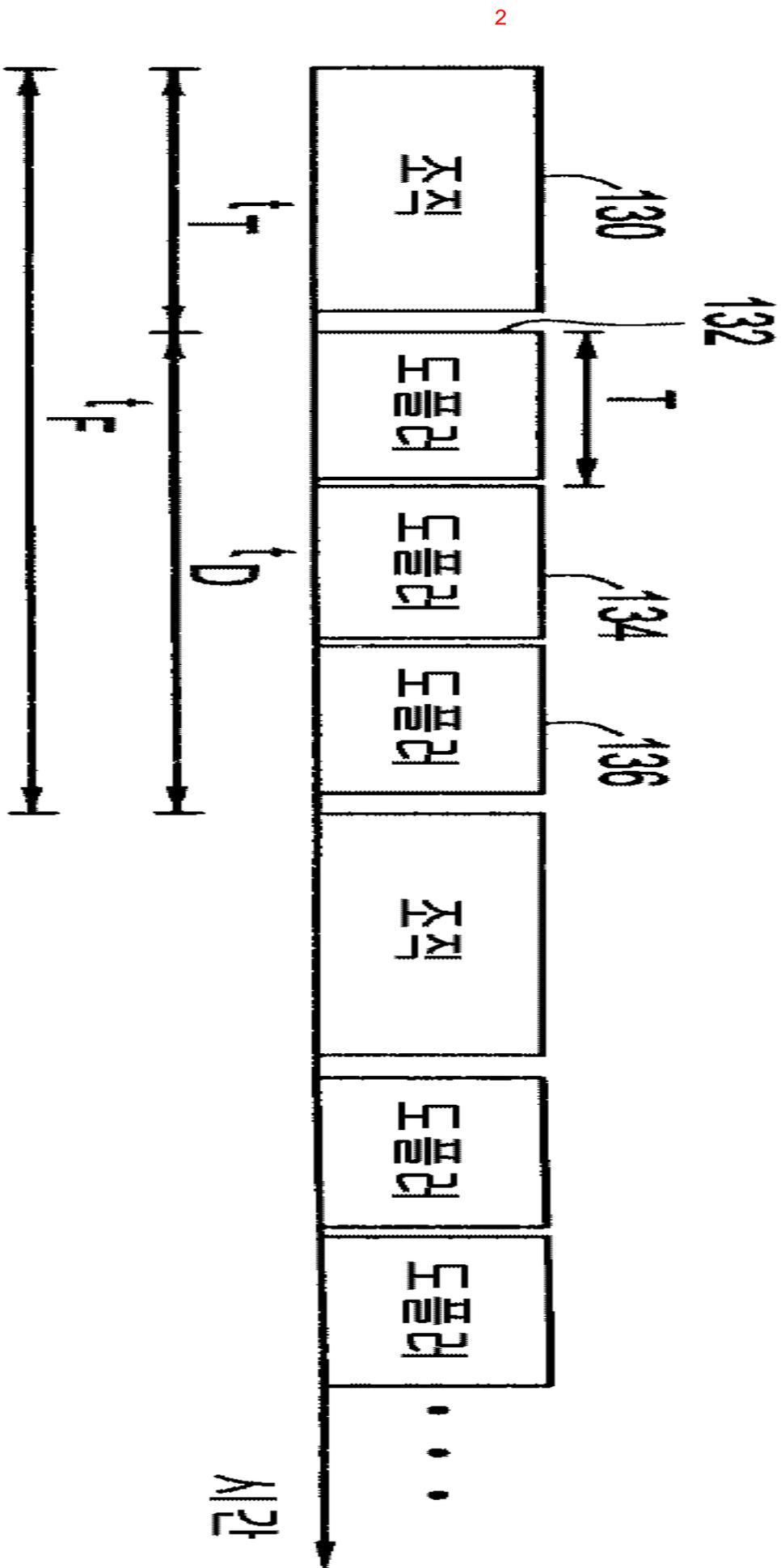


$$N_{int} = 1$$

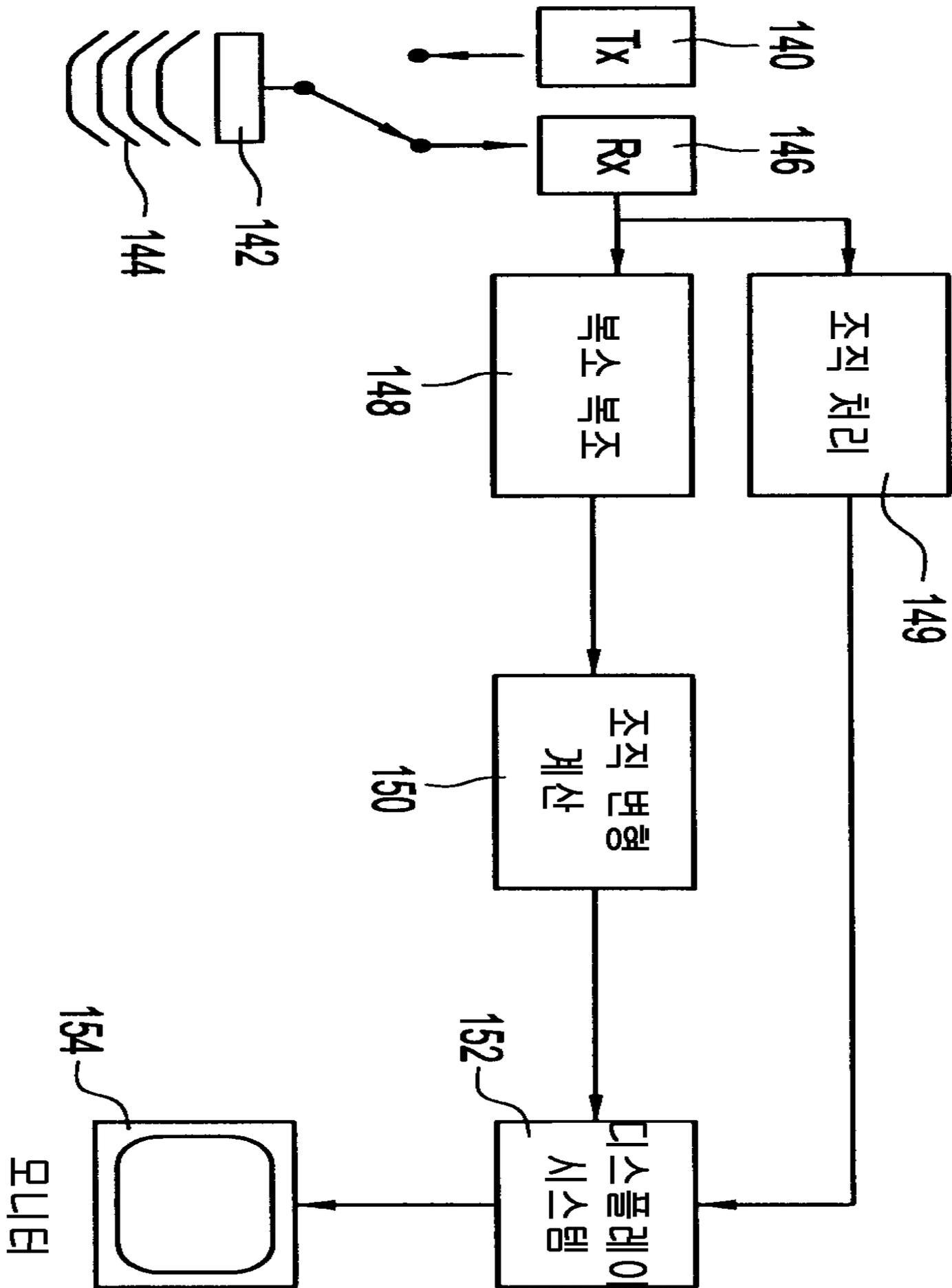


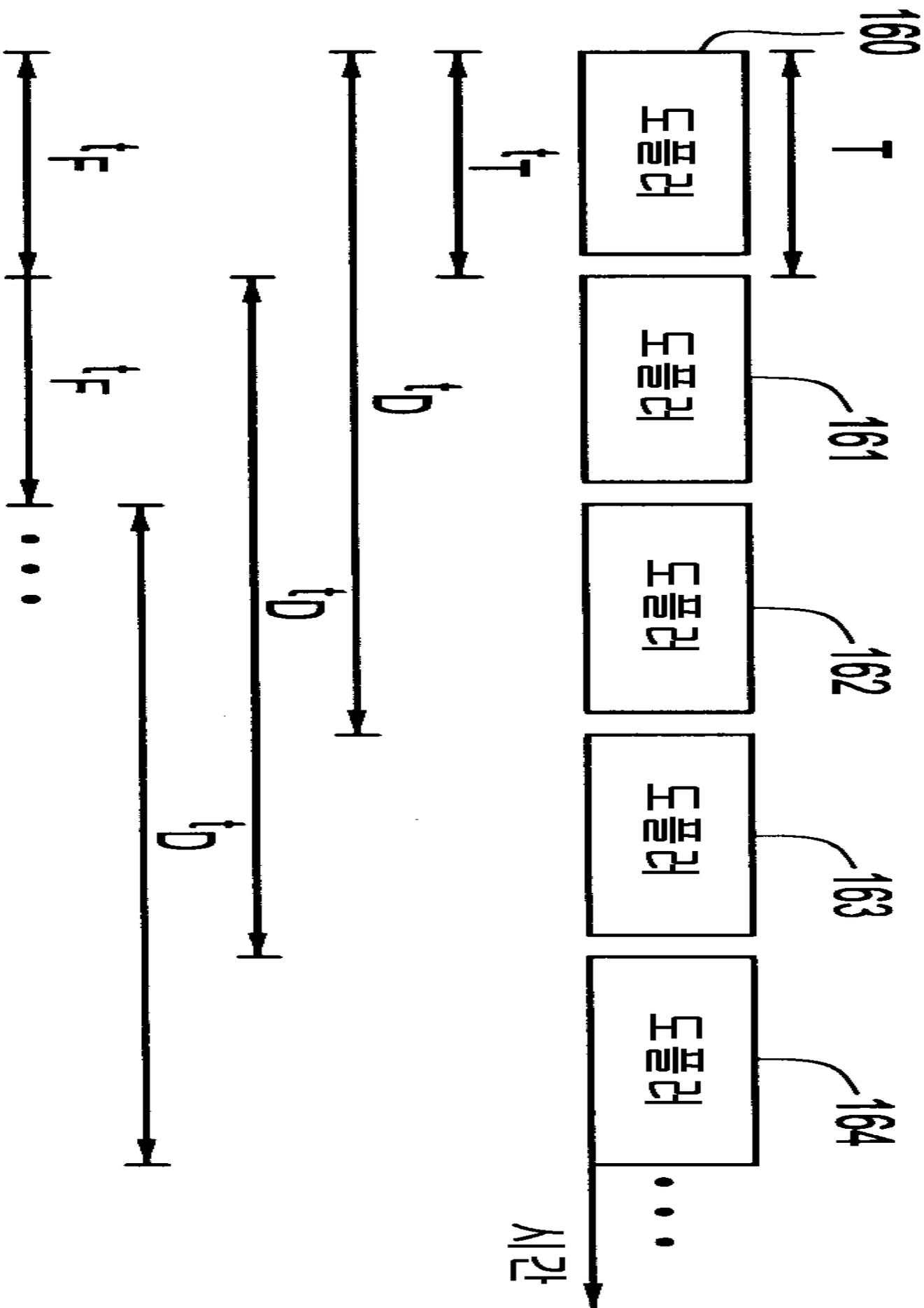
1

(종래기술)

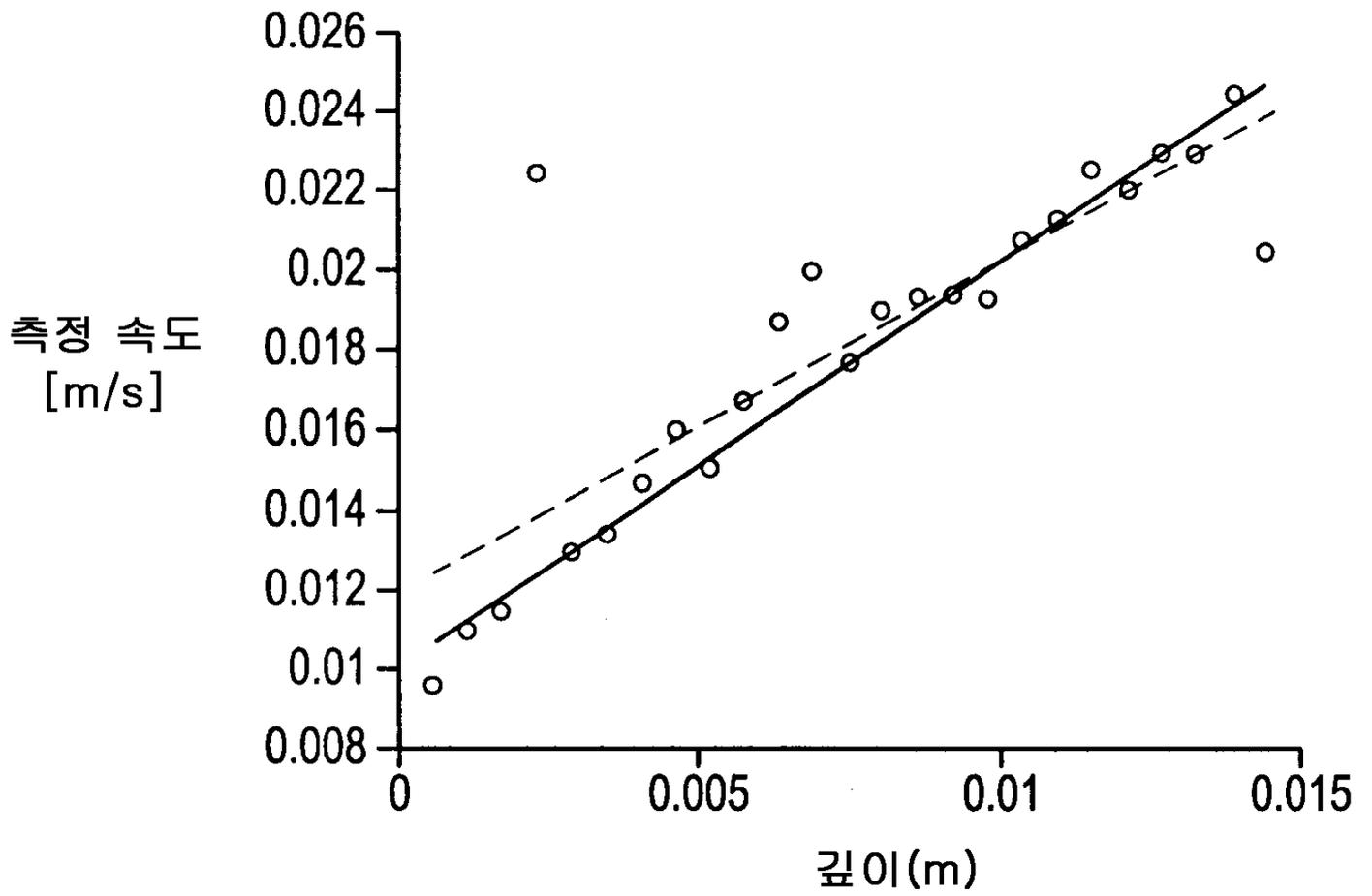


3

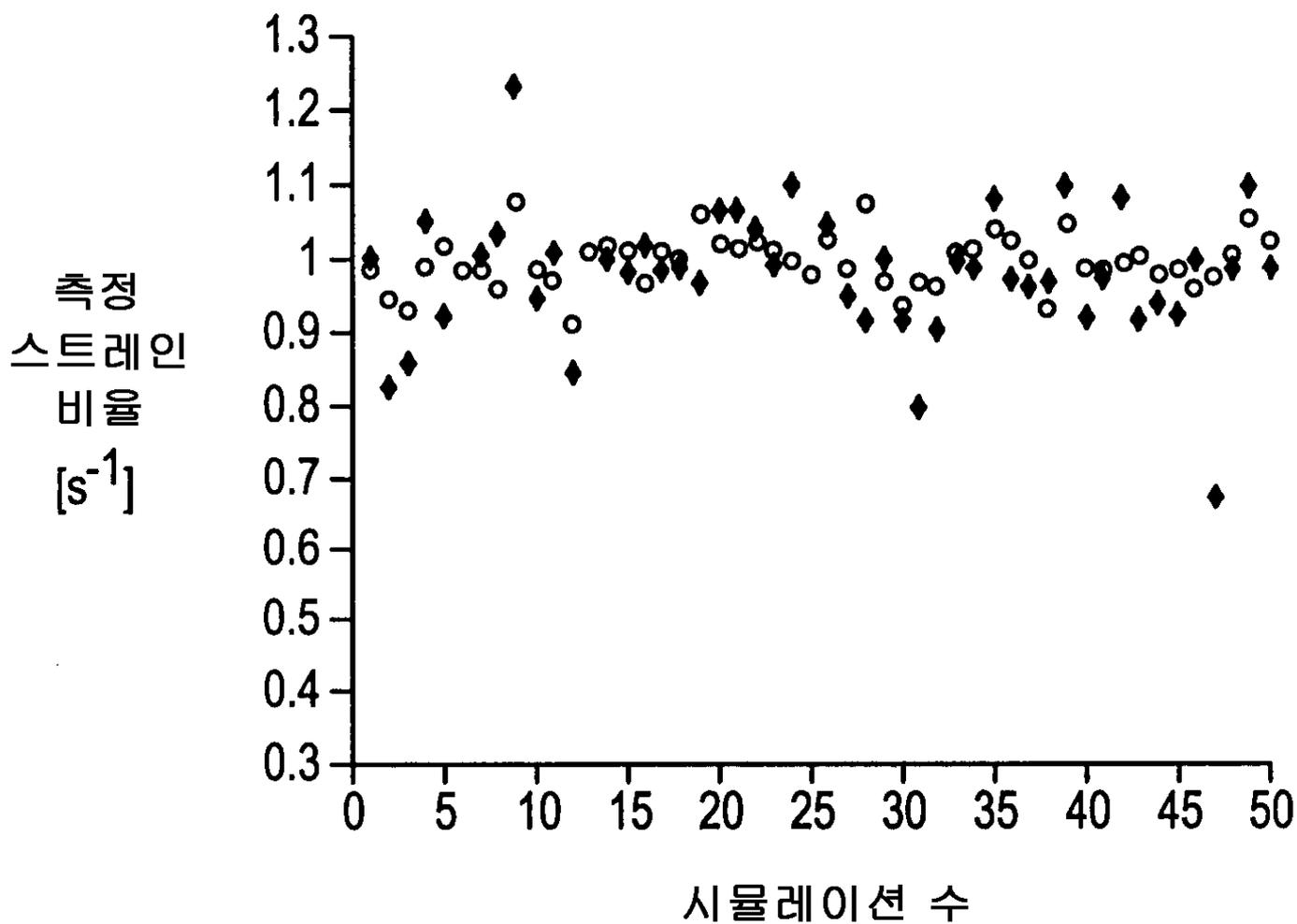




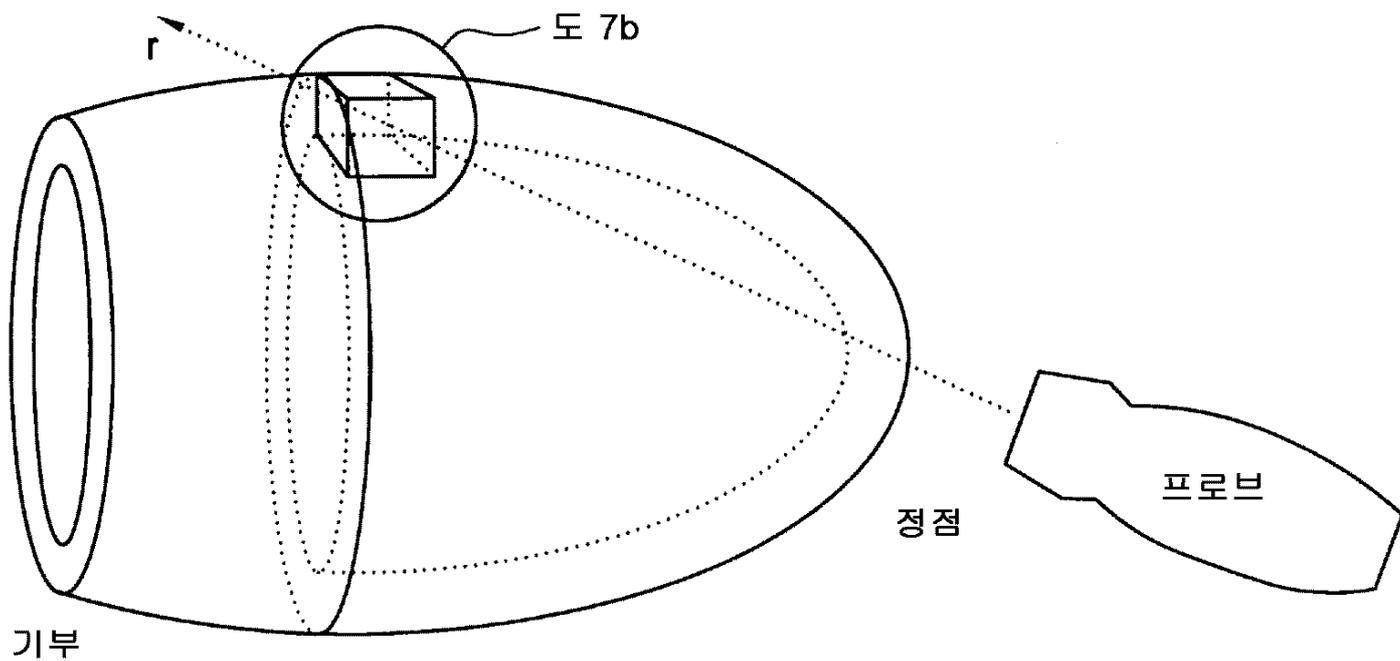
5



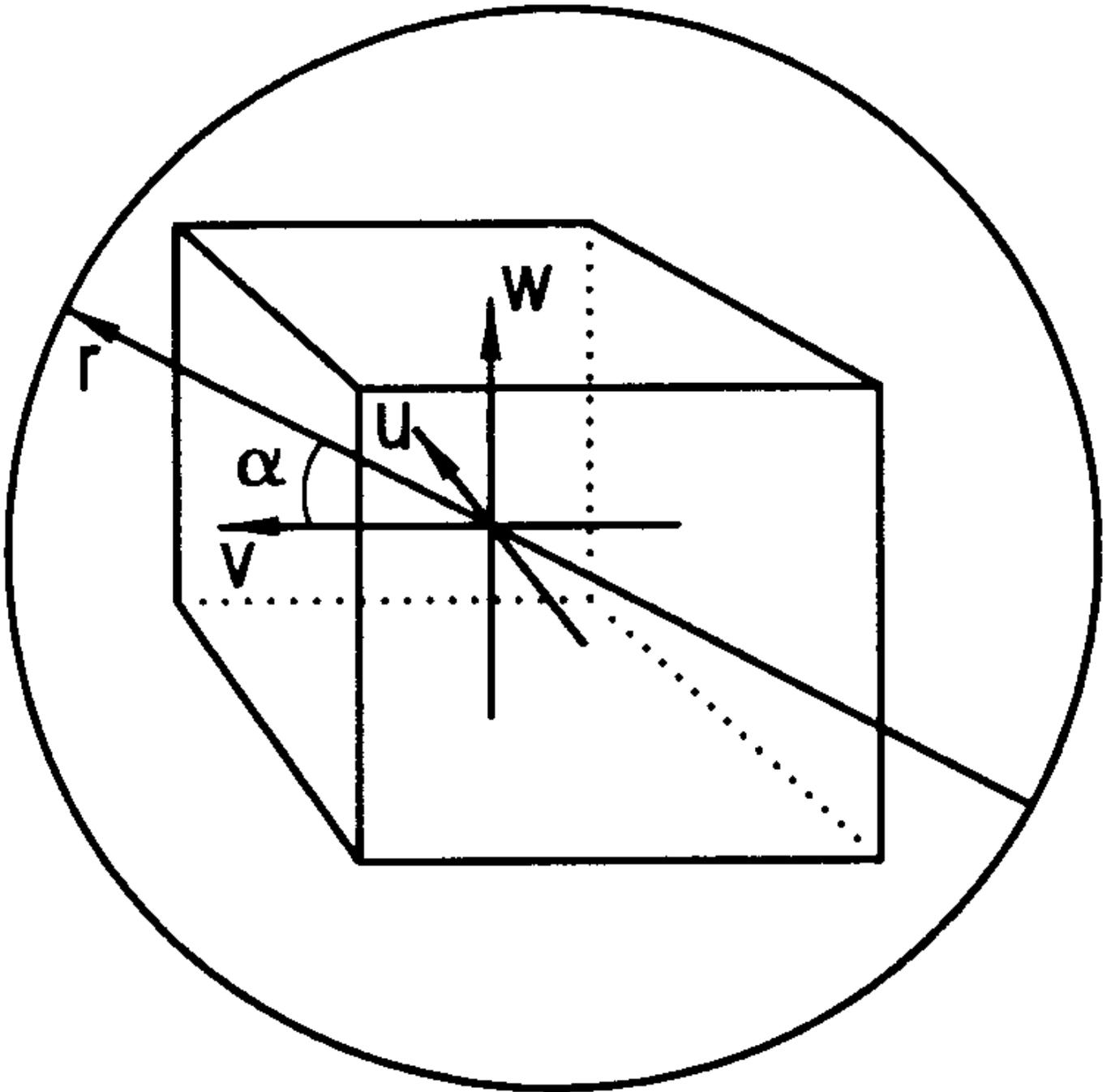
6



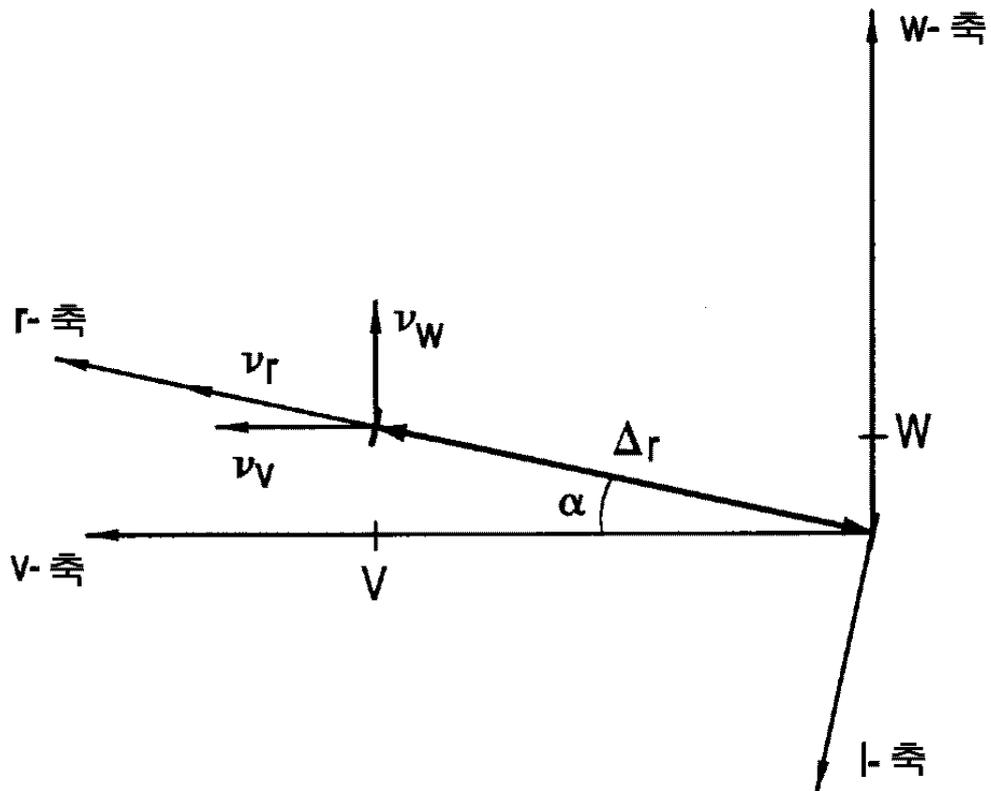
7a



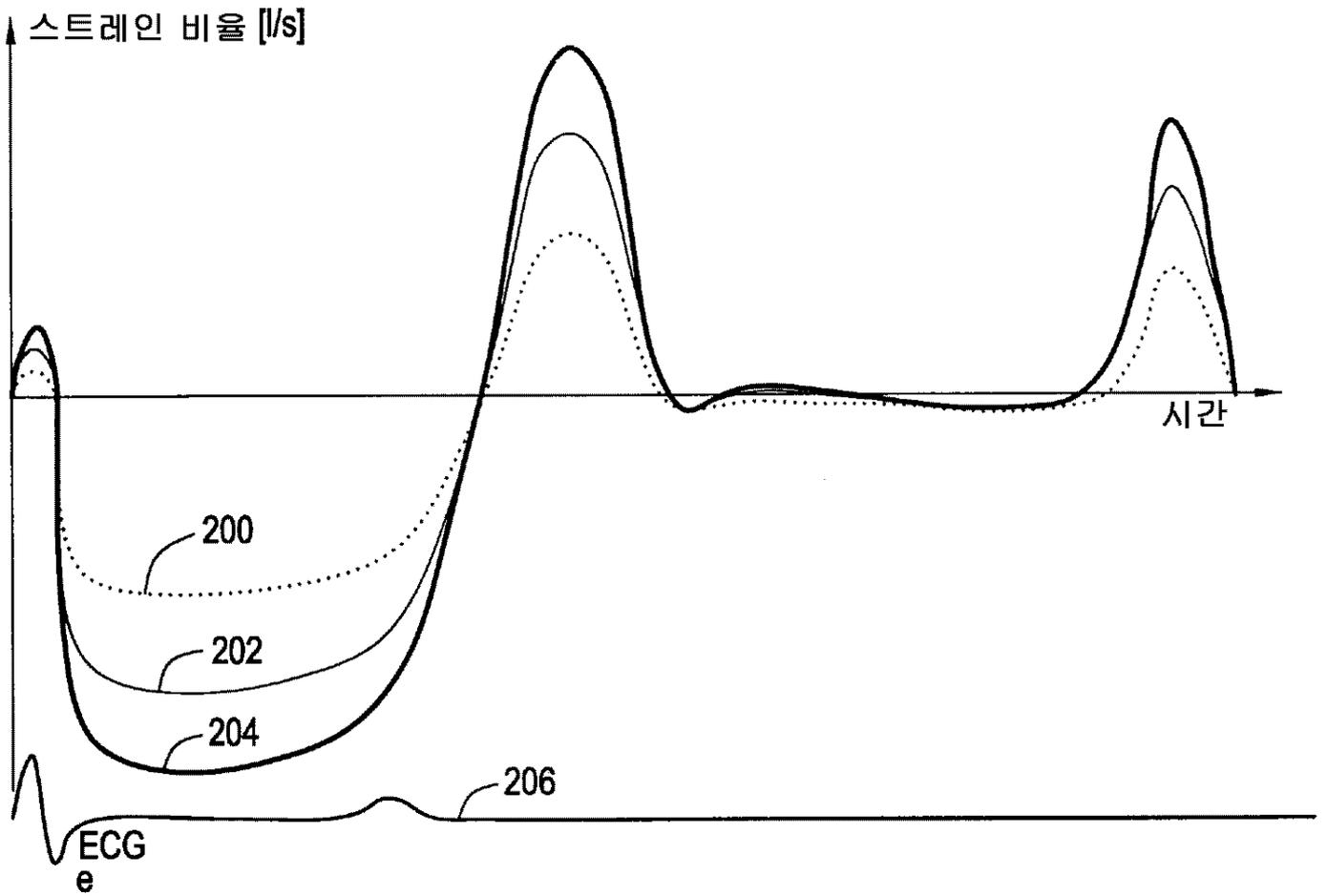
7b



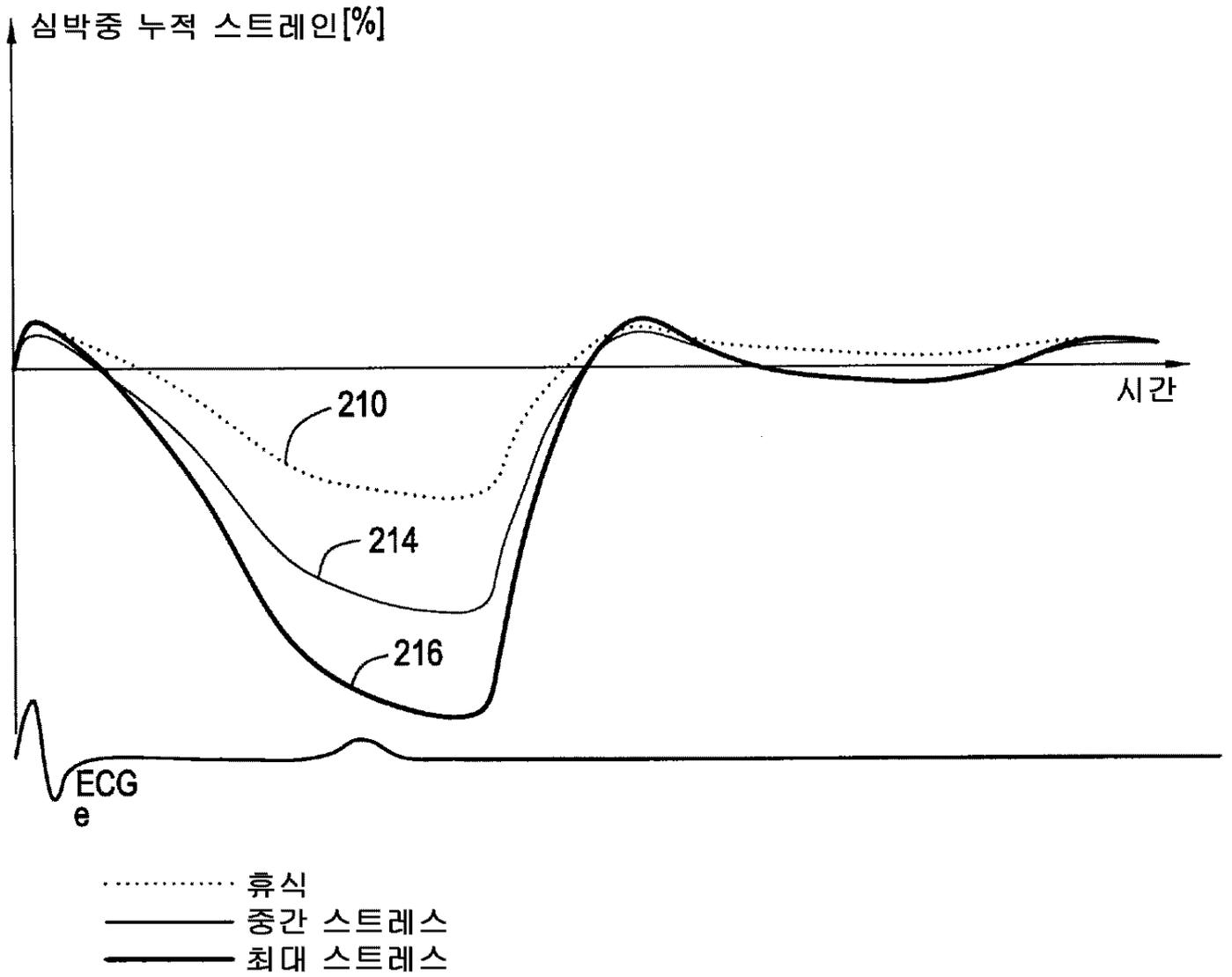
심장 외측

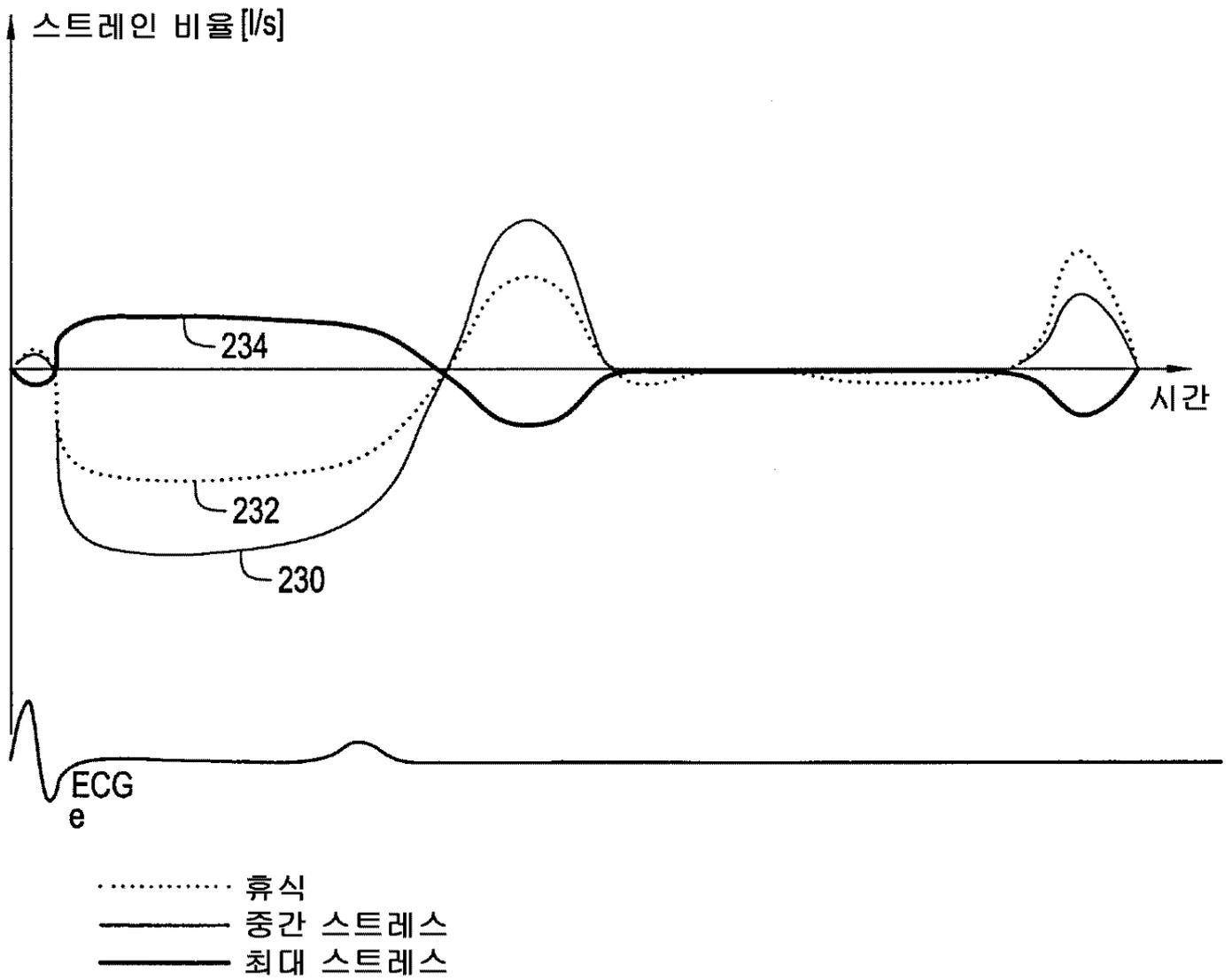


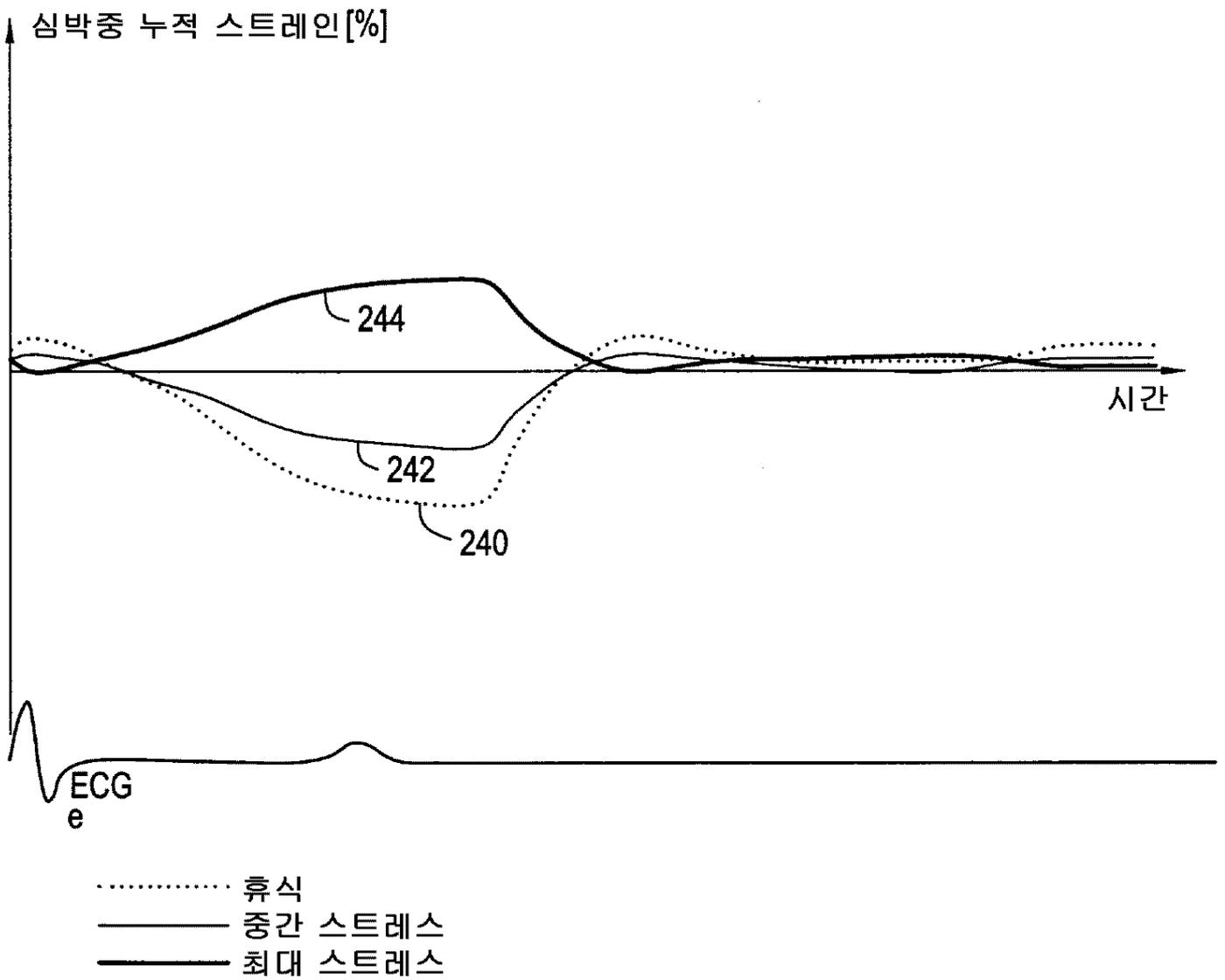
심장 내측

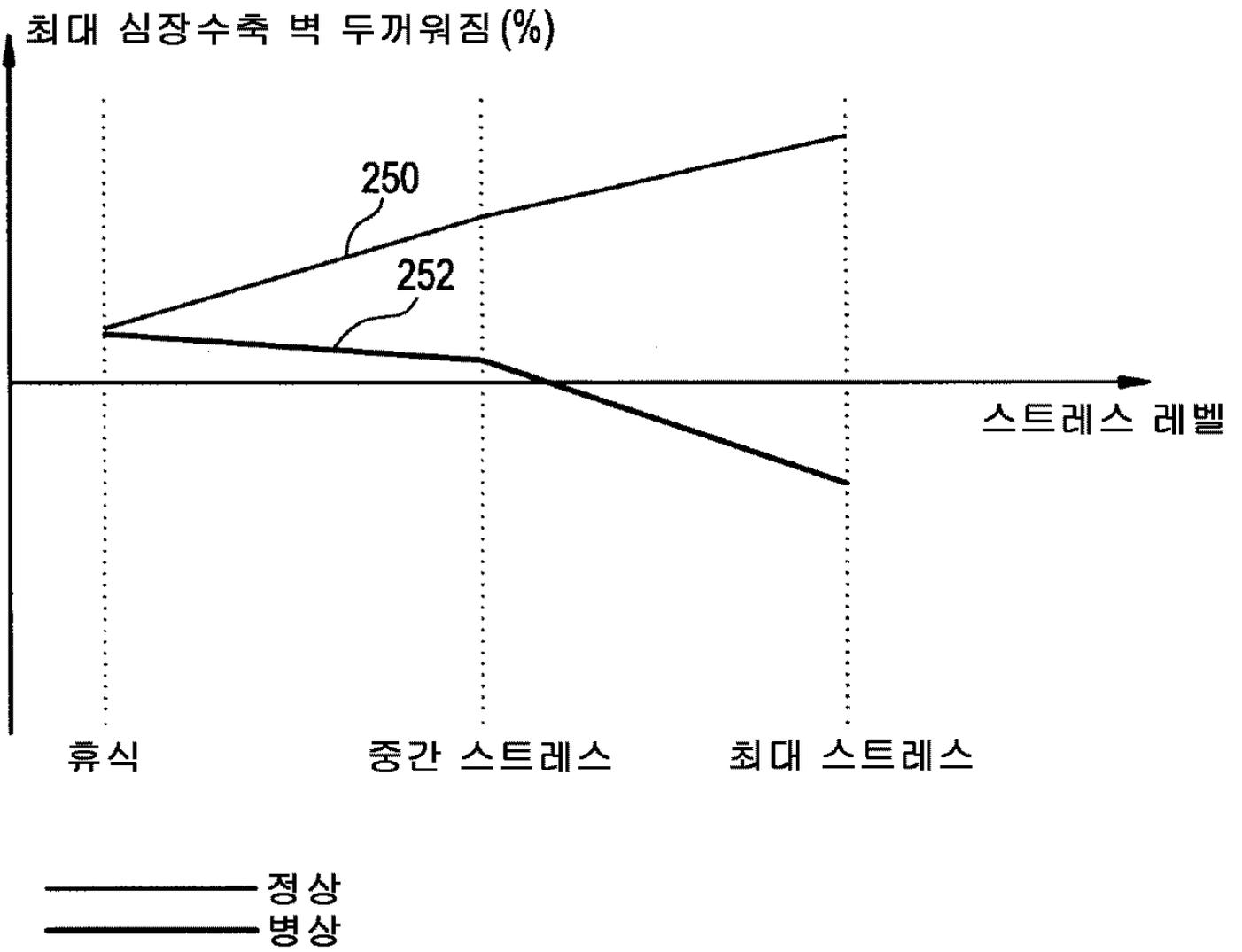


- 휴식
- 중간 스트레스
- 최대 스트레스





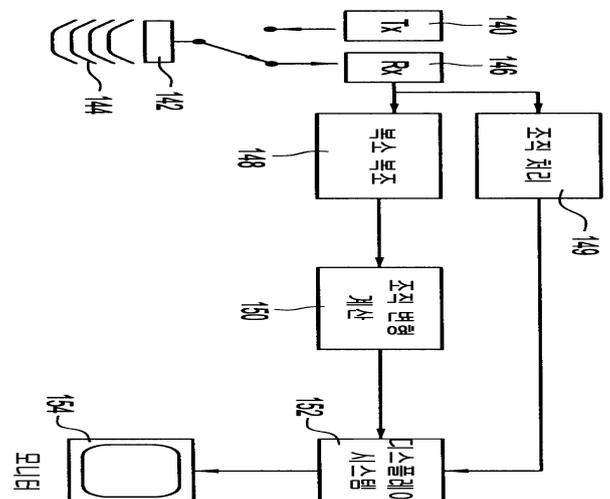




专利名称(译)	用于在超声成像中提供组织变形的实时计算和显示的方法和设备		
公开(公告)号	KR1020010067091A	公开(公告)日	2001-07-12
申请号	KR1020000048514	申请日	2000-08-22
[标]申请(专利权)人(译)	慕évingmed超声		
申请(专利权)人(译)	这冰梅德拉萨的的售后服务		
当前申请(专利权)人(译)	这冰梅德拉萨的的售后服务		
[标]发明人	TORP HANSGARMANN 토프한스가먼 OLSTAD BJORN 올스타드브존 HEIMDAL ANDREAS 헤임달안드레아스 BJAERUM STEINAR 브저름스테이나		
发明人	토프한스가먼 올스타드브존 헤임달안드레아스 브저름스테이나		
IPC分类号	A61B5/0452 G01S7/52 G01S15/58 A61B A61B8/13 G01S15/89 A61B8/08 G01S15/00 A61B5/0456		
CPC分类号	A61B8/488 A61B8/543 A61B5/7239 G01S7/52038 A61B5/0456 A61B8/485 G01S7/52085 G01S15/8979 G01S15/584 G01S7/52042 G01S7/52036 G01S7/52095 G01S7/52057		
代理人(译)	KIM, CHANG SE		
优先权	09/432061 1999-11-02 US 60/150265 1999-08-23 US		
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外部链接	Espacenet		

摘要(译)

公开了用于计算组织变化参数和显示的超声系统和方法。关于组织速度成像或应变率成像，使用允许高帧速率的超声采集技术。根据该采集技术，相同的超声波脉冲用于组织图像和基于多普勒的图像。它是通过累积关于被称为组织改变参数的应变继续的框架的应变率估计来计算的，任意截面。该部分可以由例如ECG轨迹中的R波生成的触发部分。通过根据组织在框架之间的初始样本体积内的相对位移来移动其中应变率累积的应变率的样本体积，可以改善其。组织的相对位移是根据样本量的检查组织速度计算的。通过自适应地改变空间偏移dr来改善基于组织速度的空间微分的应变率的估计。为了覆盖整个纹理段（例如，核心墙宽度），而这个空间偏移dr就像在那里保持两个样本体积组合段在偏移的两端都可以最大化。通过判断这是否是各种参数的关键性（自相关函数的大小具有例如灰度值，绝对值，功率估计值和单位时间延迟和/或样本体积的应变相关性在其完成的空间偏移中给出。使用广义应变率估计器，它是建立在应变率具有不同空间偏移的2个样本应变率估计的加重总和的基础上，可以推测。加权值与关于每个空间偏移的应变率相关估计的大小成比例。因此，与噪声相关的样本的影响，换句话



说，故障减少了。公开了除了正常时间延迟之外还使用空间延迟的改进的信号相关估计器。空间延迟可以节省组织速度。改进的信号相关估计器可以共同用于估计组织速度和应变率。可以假设它是减少它维持的混叠的方法。所接收的超声信号的三个副本在三个中心频率中过滤带通。该中心是以三个中心频率中的超声信号的二次谐波为中心。标准组织速度假定从两个信号滤除外部频率的中心。它用于从多个组织速度中选择一个组织速度，其中在来自中心信号的二次谐波中假定标准组织速度。公开了在任意方向上不是方向的方法，应变率估计组织速度数据，当然，来自样品体积周围的小目标区域的超声波束。组织速度，组织速度积分和定量组织变化参数如应变率和/或应变可以提供关于组织速度，组织速度积分和组织变化参数，如应变率和/或应变作为时间和/或空间位置的函数。例如，关于三个不同的应力水平或应变值的应变率可以一起示出心脏周期的时间。它随着心壁的最大收缩而变厚，从应变率中得出的参数如百分比，或应变率可以说明各种压力水平。