

MRI

Active Noise Control for Target Point Inside Bore Using Property of MRI Noise

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Key Words : MRI(Magnetic Resonance Imager,), ANC(Active Noise Control,)

ABSTRACT

Recently, MRI(magnetic resonance imager) scanner is continually used for medical diagnosis and many biomedical researches. When it operates, however, intense noise is generated. The SPL(sound pressure level) of the noise approaches 130 dB especially in 3 T(Tesla) MRI. Meanwhile, more than 3 T MRI scanners have been developed to get higher-resolution images, so louder noise is expected in the future. The intense noise makes patients feel nervous and uncomfortable. Moreover, it could possibly cause hearing loss to patient in extreme cases. For this reason, some active noise control systems have been researched. One of them used feedback Filtered-X LMS(FXLMS) algorithm which is able to control only narrowband noises and possible to diverge in severe case. In this paper, we determine the property of MRI noise. Using the property, we applied a method of open-loop and adaptive control for reducing MRI noise at target point inside bore. We verified performance of the method with computer simulation and preliminary experiment. The results demonstrate that the method can effectively reduce MRI noise at target point.

Nomenclature

d :		s :	가
L :		μ :	(step-size)
x_c :			
x_s :	MRI		CT
w_c :	X-ray		가
w_s :			
y :	3T MRI		130 dB
e :			

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가

(1)

3가 가)

가 (2)

가

가

MRI 가 가

(3)

(4.5) MRI

FXLMS

(6)

MRI

2. MRI

2.1 MRI

MRI

2

(isocenter)

1 , , Fig.

GRE 가

Fig. 2

95 % 가

MRI 가

2.2 MRI

MRI

가 GRE

Figs. 3, 4

가

가

가 MRI

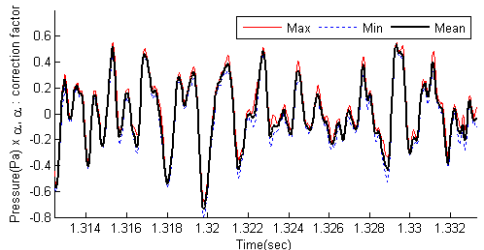


Fig. 1 Maximum, minimum and mean value of signal along samples

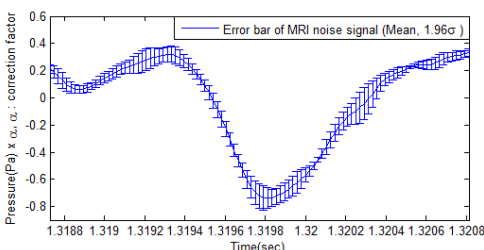


Fig. 2 Error bar of mean and standard deviation along samples

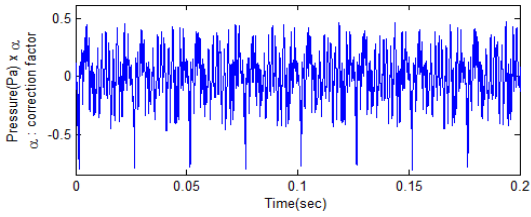


Fig. 3 MRI noise in time domain

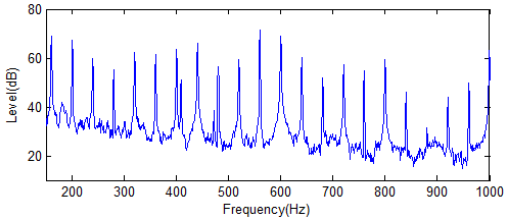


Fig. 4 MRI noise in frequency domain

3.

3.1

MRI FXLMS

FXLMS

가

가

(coherence) 가

가

가

(2)

MRI

가 가

(,)

(7)

가

FXLMS

3.2

(1)

2

, MRI

가 가

가

MRI

, 가

가

가

, MRI

가

가

가 가

가

$$\nabla e(n) = -s(n) * \mathbf{x}(n) \equiv -\mathbf{x}'(n) \tag{8}$$

$$\nabla \hat{\xi}(n) = -2\mathbf{x}'(n)e(n) \tag{9}$$

$$\mathbf{w}(n+1) = \mathbf{w}(n) + \mu \mathbf{x}'(n)e(n) \tag{10}$$

where $x' \approx \hat{s} * x$ (11)

(9)

4.

4.1

GRE
MRI
48 kHz

2

4.2

Figs. 6~7

150 Hz~2.5 kHz

48 kHz

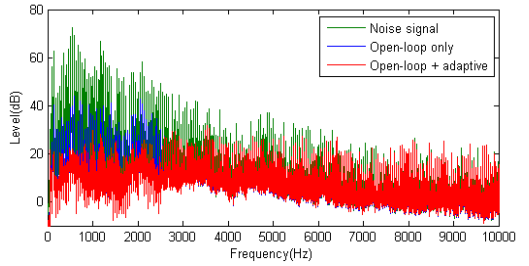


Fig. 6 Noise signal and error signals(open-loop control only/open-loop and adaptive control) in the frequency domain

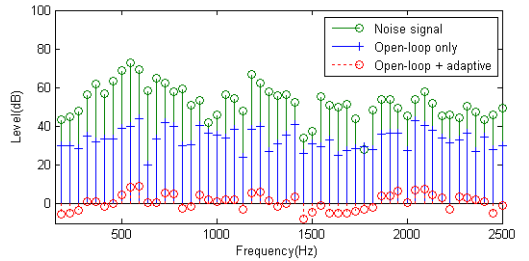


Fig. 7 Noise signal and error signals(open-loop control only/open-loop and adaptive control) in the target frequency band

5.

5.1

MRI

DSP(digital signal processor – DS1103, DSPACE), 1

(1/2, B&K), 2

(NEXUS, B&K),

(YAMAHA),

가

가

가

1.5 m

20°

30 dB

가 2.5 kHz

DSP 가

30 dB

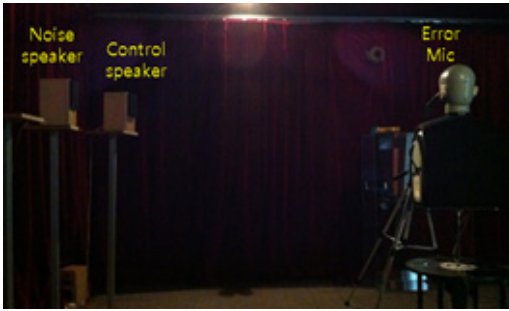


Fig. 8 Environment of experiment

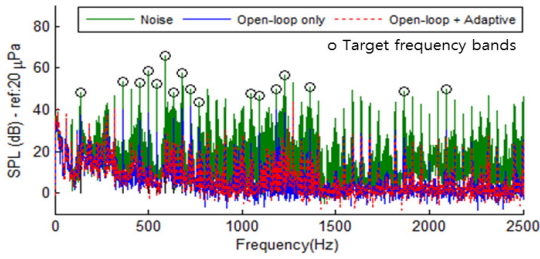


Fig. 9 Noise and error signals(open-loop control only / open-loop and adaptive control) in the frequency domain

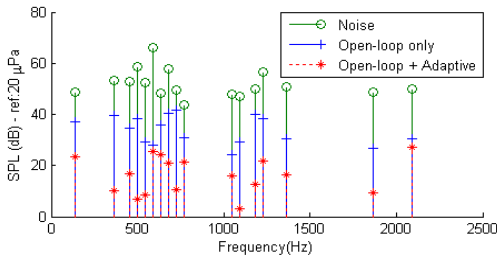


Fig. 10 Noise and error signals(open-loop control only/open-loop and adaptive control) in the target frequency band

5.2

가 3가
 . Figs. 8~9
 가
 ,
 20 dB
 2.5 kHz 20 dB
 , 1270 Hz

6.

가 MRI 가 MRI
 ,
 MRI
 . GRE
 ,
 20 dB

가 48 kHz
 , 0.021 ms
 .
 (time table)

가
 가 20

, MRI
 ,
 2010 ()
 (No. 10037244)
 2013 ()
 (No. 2010-0028680).

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