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(fMRI)

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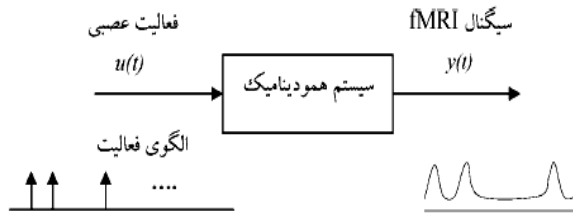
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(fMRI)

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(fMRI)

(fMRI)

BOLD

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fMRI

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<sup>1</sup> Functional Magnetic Resonance Imaging

<sup>2</sup> Blood Oxygenation Level Dependant

<sup>3</sup> Steepest descent

( )

BOLD  $f$

$q$   $v$

:[ ]

$$f'_{in} = s$$

( )

fMRI

$$s' = \varepsilon U(t) - s / \tau_s - (f_{in} - 1) / \tau_f$$

( )

)

$U(t)$

(

BOLD

fMRI

)

)  $E_0$

(

(

)

(

$$y(t) = V_0 \times$$

$$\times \left[ 7E_0(1-q) + 2 \left( 1 - \frac{q}{v} \right) + (2E_0 - 0.2)(1-v) \right] \quad ( )$$

$V_0$

$$(v' = dv/dt)$$

.[ ]

$$\tau_0 v' = f_{in} - f_{out}(v) \quad ( )$$

( )

$$f_{out} = v^{1/\alpha} \quad ( )$$

$q'$

$$\tau_0 q' = f_{in} \frac{E(f_{in}, E_0)}{E_0} - f_{out}(v) q / v \quad ( )$$

fMRI Data Center

$$E(f_{in}, E_0) = 1 - (1 - E_0)^{1/f_{in}}$$

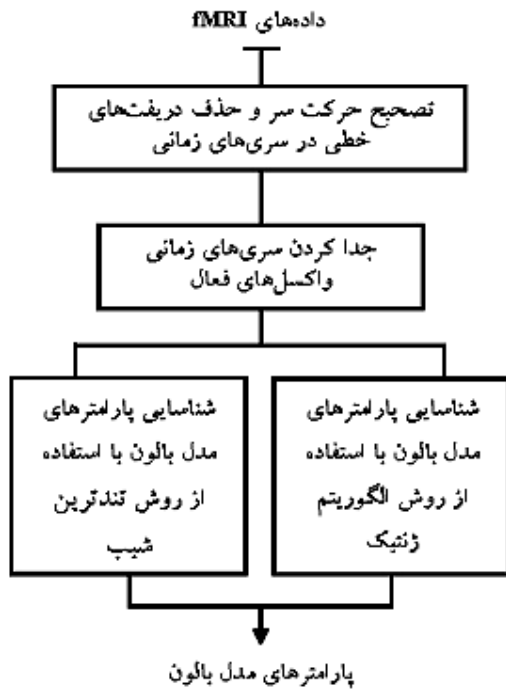
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<sup>4</sup> Block design

<sup>5</sup> Event-related

<sup>6</sup> Finger tapping



× ×

/ (TR)

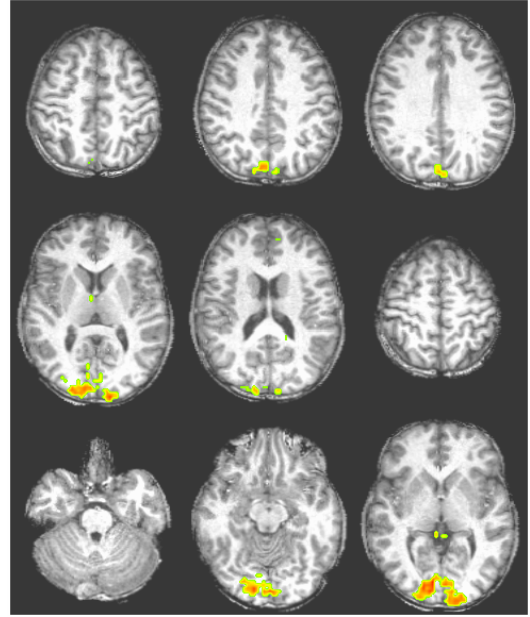
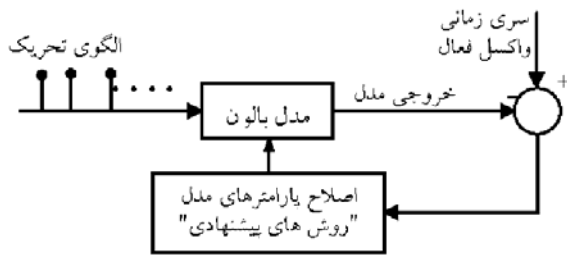
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fMRI

fMRI

fMRI

( [ ] AFNI )



$$y(n) \quad n \quad e(n)$$

$$a(n+1) = a(n) - \rho * Grad(e(n)) \quad ( )$$

$$e(n-1) \quad e(n) \quad /$$

BOLD

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simulink

( / )

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$$Grad(e) = \frac{e(n) - e(n-1)}{a(n) - a(n-1)}$$

$$e(n) = y_{real} - y(n) \quad ( )$$

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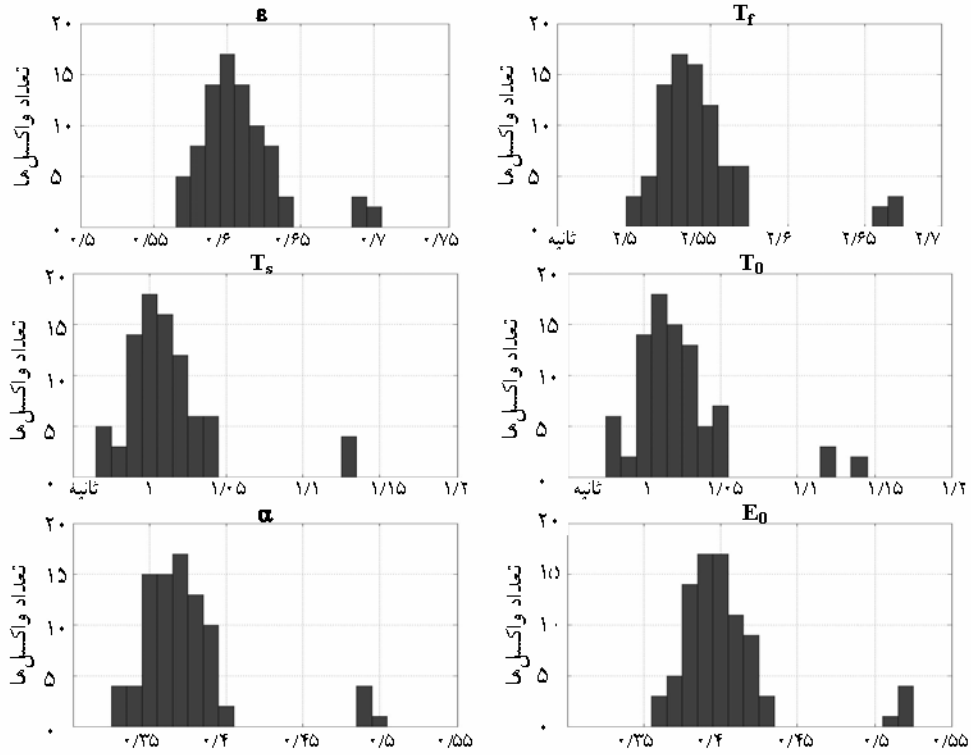
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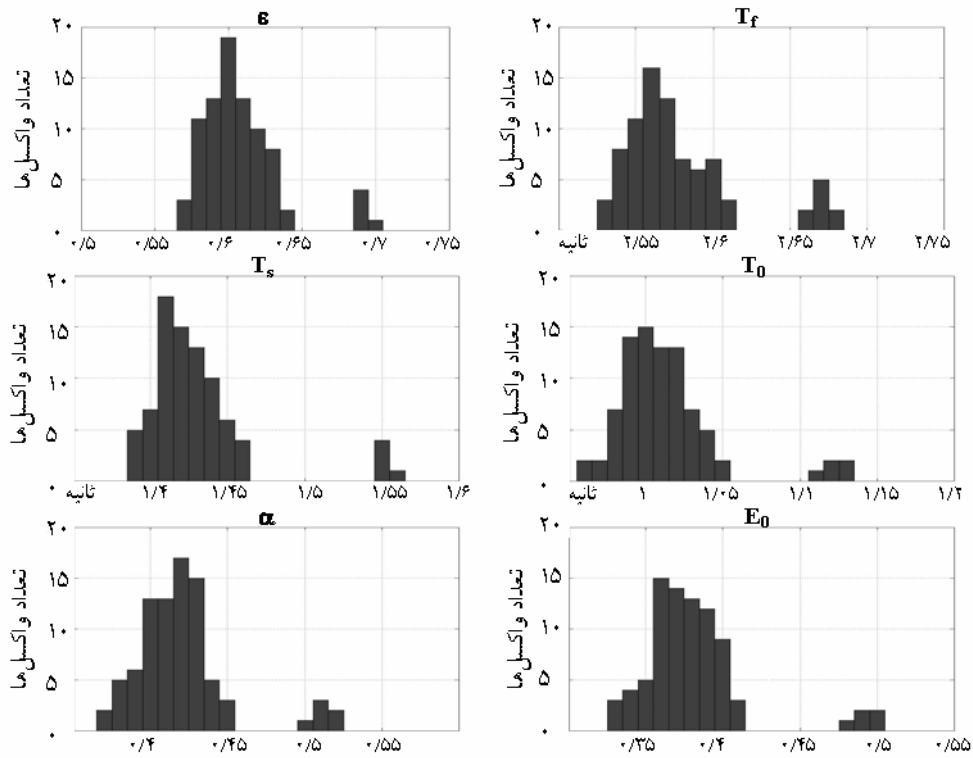
fMRI (

) fMRI

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( E<sub>0</sub> ε α )

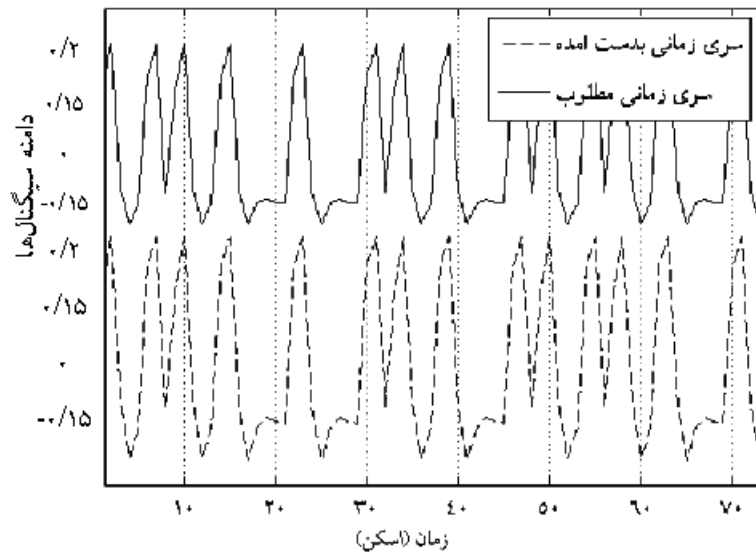


( E<sub>0</sub> ε α )

(  $\alpha$   $E_0$   $\varepsilon$  )

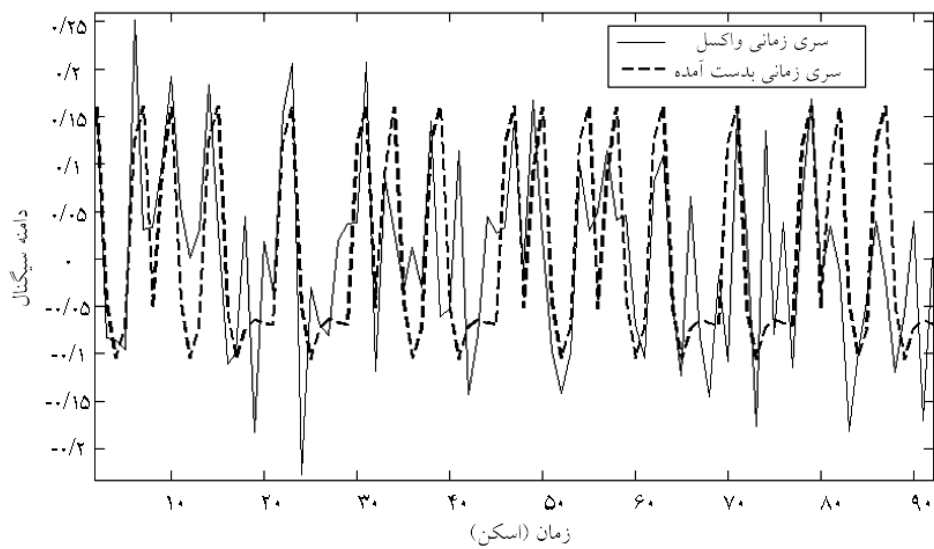
$E_0$	$\alpha$	$T_0$ ( )	$T_r$ ( )	$T_s$ ( )	$\varepsilon$
/	/	/	/	/	/
/	/	/	/	/	/
/	/	/	/	/	/

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fMRI

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- [5] Vazquez AL, Noll DC; Nonlinear aspects of the BOLD response in functional MRI; *NeuroImage* 2001; 13: 1–12.
- [6] Miller KL, Luh W, Liu TT, Martinez A, Obata T, Wong EC, Frank LR, Buxton RB; Nonlinear temporal dynamics of the cerebral blood flow response; *Human Brain Mapping* 2001; 13: 1–12.
- [7] Buxton RB, Wong EC, Frank LR; Dynamics of blood flow and oxygenation changes during brain activation: The Balloon model; *Magnetic Resonance in Medicine* 1998; 39: 855–864.
- [8] Friston KJ, Mechelli A, Turner R, Price CJ; Nonlinear responses in fMRI: The Balloon model, Volterra kernels, and other hemodynamics; *NeuroImage* 2000; 12: 466–477.
- [9] Gholam-Ali H-Z, Babak A, and Hamid S; A signal subspace approach for modeling the hemodynamic response in fMRI; *Magnetic Resonance Imaging* 2003; 21: 835–843. [ ]
- [10] Buckner RL, Snyder AZ, Sanders AL, Raichle ME, Morris JC; Functional brain imaging of young, nondemented, and demented older adults; *Journal of Cognitive Neuroscience* 2000; 12(2): 24–34.
- [11] fMRI data center at <http://www.fmridc.org> (Accession #: 2-2000-1118W).
- [12] Talairach J, Tournoux P; A Co-planar stereotaxic atlas of a human brain; Thieme, Stuttgart, 1988.
- [13] Chen B, Lee F, Peng S; Maximum likelihood parameter estimation of F-ARIMA process using the genetic algorithm in the frequency domain; *IEEE Transaction on Signal Processing* 2002; 50: 2208–2220.
- [2] Cohen MS; Parametric analysis of fMRI data using linear systems methods; *NeuroImage* 1997; 6:93–103.
- [3] Bandettini PA, Cox RW; Event-related fMRI contrast when using constant inter stimulus interval: Theory and experiment; *Magnetic Resonance in Medicine* 2000; 43: 540–548.
- [4] Friston KJ, Josephs O, Rees G, Turner R; Nonlinear event-related response in fMRI; *Magnetic Resonance in Medicine* 1998; 39: 41–52.