

Tehnici de difuzie si de fuziune pentru restaurarea si imbunatatirea imaginilor

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Structura prezentarii

- Formalismul EDP in procesarea imaginilor
- Tehnici de fuziune a imaginilor
- Restaurare si imbunatatire de imagini prin difuzie si fuziune
- Rezultate experimentale
- Concluzii si perspective

Formalismul EDP in procesarea imaginilor

- Model general de procesare a imaginilor prin EDP

$$\frac{\partial U}{\partial t} = F(x, y, t, U, U_x, U_y, U_{xx}, U_{yy})$$

F – operator ce caracterizeaza un algoritm dedicat unui anumit tip de procesare

U – functie luminanta ; x,y – coordonate spatiale,

T – scara de observare

- Exemple de ecuatii cu derivate partiale

EDP de difuzie isotropica

$$\frac{\partial U}{\partial t} = \text{div}[c(x,y,t)\nabla U(x,y,t)]_{c(x,y,t)=ct} = \Delta U$$

Formalismul EDP in procesarea imaginilor

**EDP de difuzie
anizotropica**

$$\begin{cases} \frac{\partial U}{\partial t} = \text{div}[c(x, y, t)\nabla U(x, y, t)] \\ c(x, y, t) = g(|\nabla U|) \end{cases}$$

g – functie descrescatoare cu rol de detector de contururi

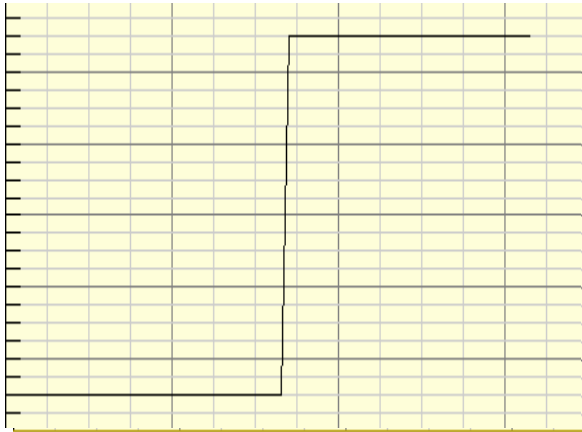


Formalismul EDP in procesarea imaginilor

Filtre de soc

$$\frac{\partial U}{\partial t} = -\text{signe}(U_{\eta\eta})|\nabla U|$$

- inversare deliberata a ecuatiei de propagare a caldurii;
- extrem de utile pentru eliminarea distorsiunilor de defocalizare de tip contururi difuze



Formalismul EDP in procesarea imaginilor

Filtre de difuzie tensoriale

$$\frac{\partial U}{\partial t} = \text{div}(D \nabla U)$$

$$D = (\vec{v}_1 | \vec{v}_2) \begin{pmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{pmatrix} \begin{pmatrix} \vec{v}_1^T \\ \vec{v}_2^T \end{pmatrix}$$

Modelul CED (Coherence Enhancing Diffusion)

$$D = J_\rho(\nabla U_\sigma) = G_\rho * J_0(\nabla U_\sigma) = \begin{pmatrix} G_\rho * \left(\frac{\partial U_\sigma}{\partial x}\right)^2 & G_\rho * \frac{\partial U_\sigma}{\partial x} \frac{\partial U_\sigma}{\partial y} \\ G_\rho * \frac{\partial U_\sigma}{\partial x} \frac{\partial U_\sigma}{\partial y} & G_\rho * \left(\frac{\partial U_\sigma}{\partial y}\right)^2 \end{pmatrix}$$



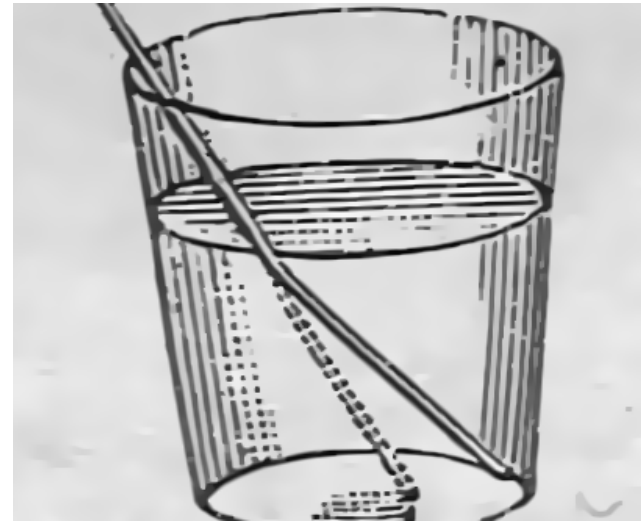
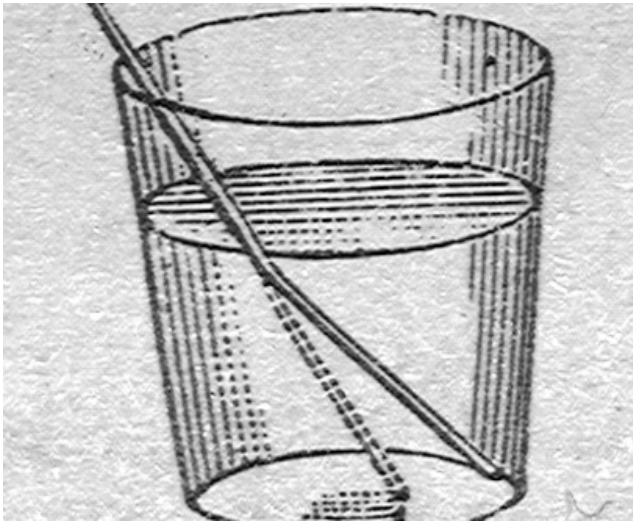
Formalismul EDP in procesarea imaginilor

Filtrul de netezire directionala adaptiva 1D/2D

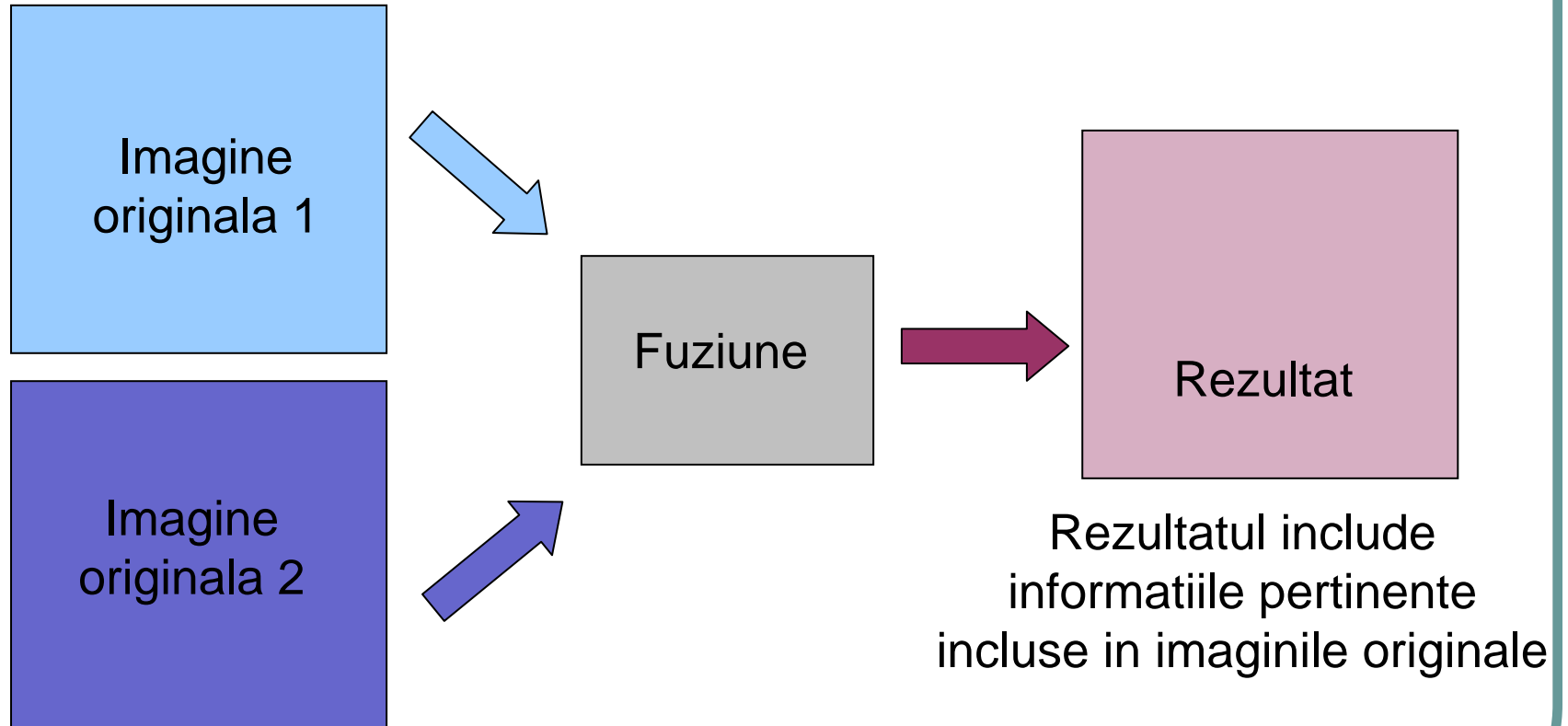
$$\frac{\partial U}{\partial t} = \frac{\partial}{\partial \xi} [g^{\xi} (U_{\sigma_{\xi}}) U_{\xi}] + \frac{\partial}{\partial \eta} [g^{\eta} (U_{\sigma_{\eta}}) U_{\eta}]$$

ξ - directiile structurilor, η - directii ortogonale

g – functie de tip Perona-Malik



Tehnici de fuziune a imaginilor



Tehnici de fuziune a imaginilor

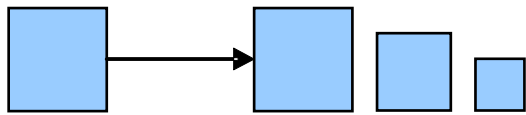
Fuziune prin descompunere piramidala

$$G_0(x, y) \equiv U(x, y)$$

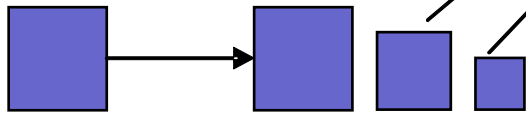
$$G_k = [w * G_{k-1}]_{\downarrow 2}$$

$$L_k = G_k - 4w * [G_{k+1}]_{\uparrow 2}$$

Imagine originala 1 Descompunere piramidala

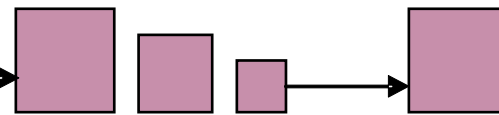


Imagine originala 2 Descompunere piramidala



Fuziune

Piramida imagine fuzionata Rezultat



Regula de fuziune opereaza pe nivelele de descompunere ale imaginilor in domeniile Laplace si Gauss

Exemple: $\tilde{L}_k(x, y) = \max [L^1_k(x, y), L^2_k(x, y)]$

$$\hat{G}_k = \tilde{L}_k + 4w * [G_{k+1}]_{\uparrow 2}$$

$$\hat{G}_0 = rezultat$$

Tehnici de fuziune a imaginilor

In abordarile clasice combinarea efectelor mai multor EDP se face prin combinatii liniare de termeni ce cuantifica contributia mai multor modele de procesare

Exemplu – modelul Kornprobst

$$\frac{\partial U}{\partial t} = \alpha_f (U - U_0) + \alpha_r [h_r (|G_\sigma * \nabla U|) U_{\eta\eta} + U_{\xi\xi}] - \alpha_e [1 - h_r (|G_\sigma * \nabla U|)] \text{sign}(G_\sigma * I)_{\eta\eta} |\nabla U|$$

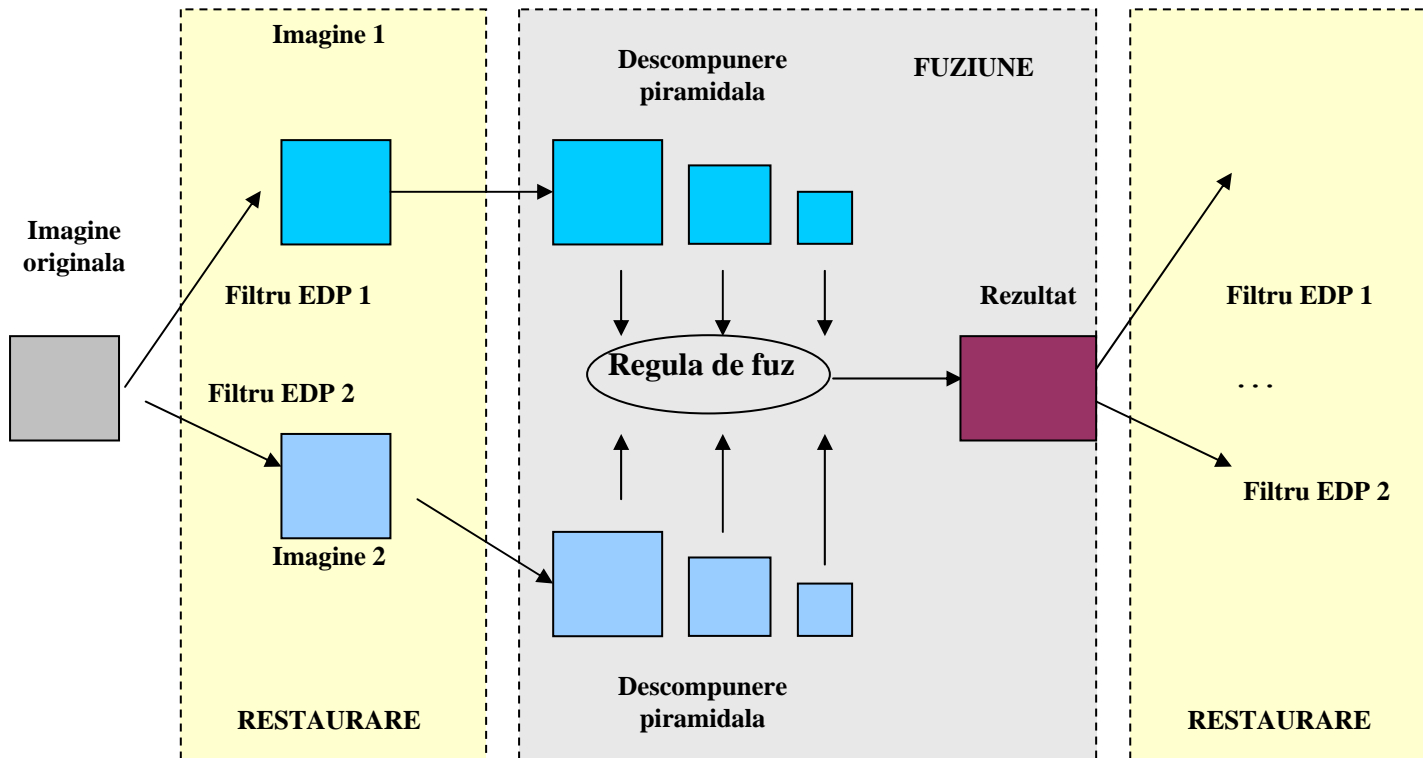
- actiunea filtrului e decisa local in functie de normele vectorilor gradienti
- filtrele sunt de acelasi tip (scalare sau tensoriale)
- un astfel de model limiteaza numarul si tipul de filtre de tip EDP ce pot fi combinate

Alternativa: dezvoltarea de noi modele de procesare prin combinarea efectelor filtrelor de tip EDP prin tehnici de fuziune a imaginilor

Restaurare si imbunatatire de imagini prin difuzie si fuziune

- Cadru teoretic

- proces iterativ compus din etape alternative de difuzie si fuziune

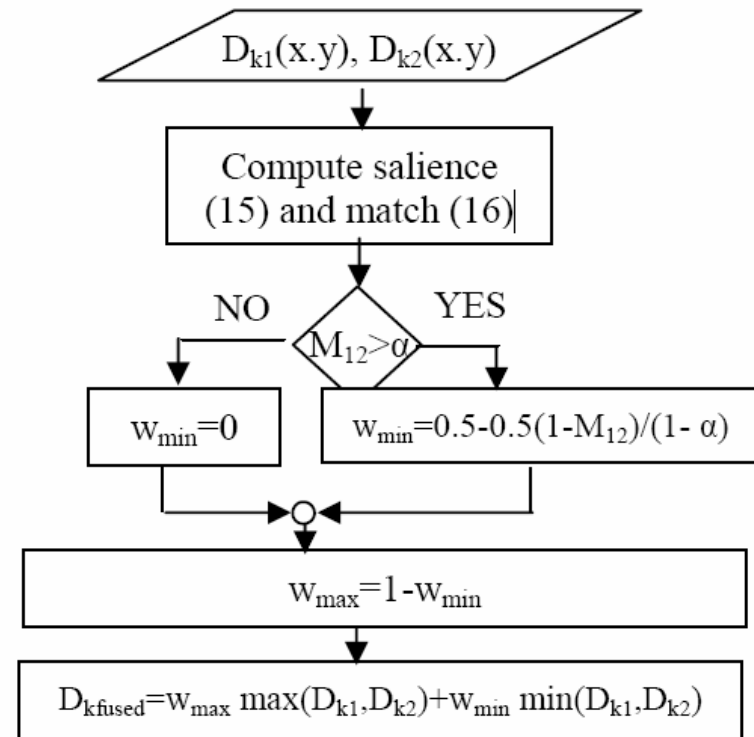


Restaurare si imbunatatire de imagini prin difuzie si fuziune

Fuziunea imaginilor are loc in domeniul descompunerii piramidale printr-o abordare de tip " salience/match "

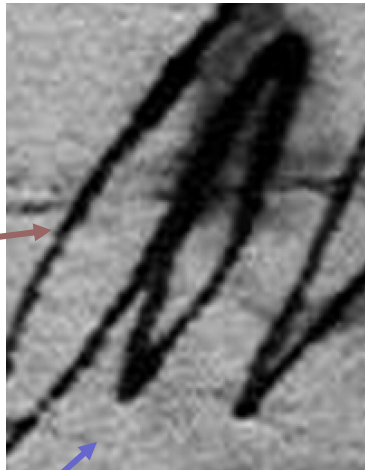
$$M_{1,2}(x, y) = \frac{2\sigma_1(x, y)\sigma_2(x, y)}{\sigma_1^2(x, y) + \sigma_2^2(x, y)}$$

- D_{k1}, D_{k2} – nivele k de acelasi tip (Laplace sau Gauss)



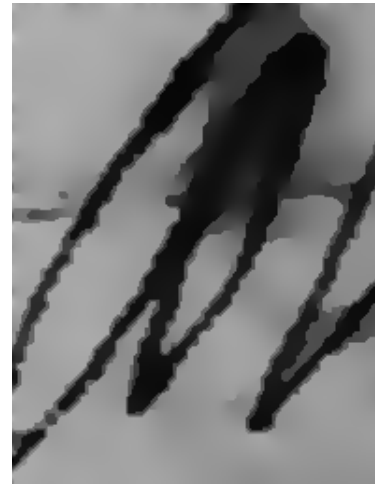
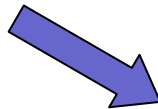
Rezultate experimentale

Prezervarea
contururilor



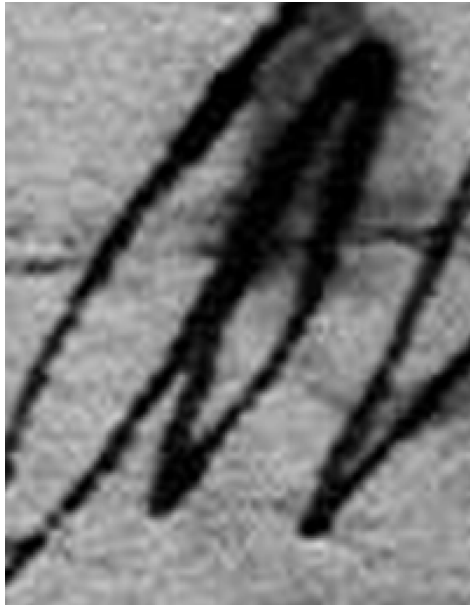
Rezultat CED

Netezire eficienta a
fondului



Rezultat Perona-Malik
(difuzie anizotropica)

Rezultate experimentale

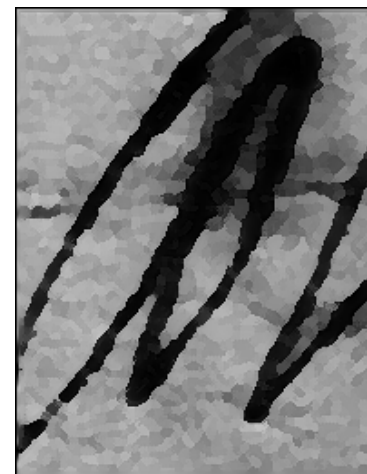
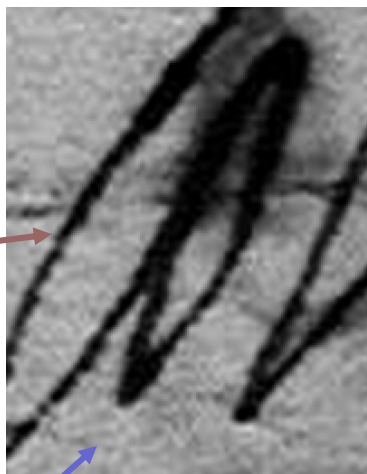


3 etape de difuzie
(25 iteratii fiecare)
si fuziune



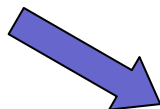
Rezultate experimentale

Accentuare a
contururilor



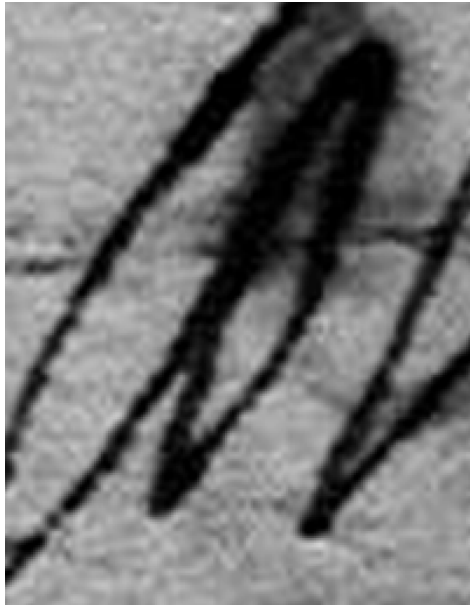
Rezultat filtre de soc

Netezire eficienta a
fondului

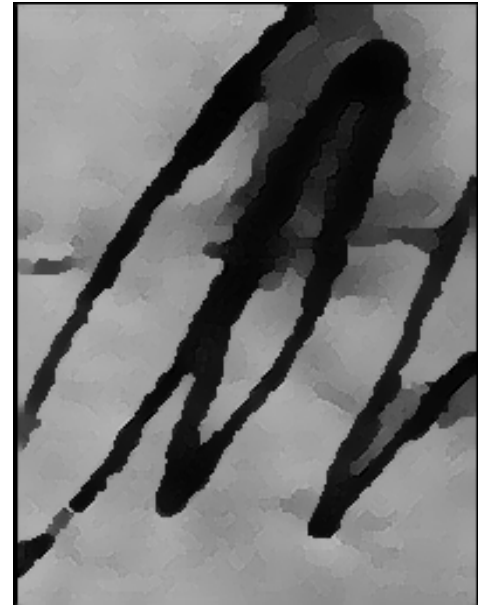


Rezultat filtru de
netezire 1D/2D

Rezultate experimentale



5 etape de difuzie
(20 iteratii) si fuziune



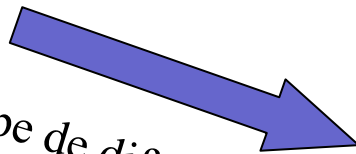
Rezultate experimentale



Rezultat Perona-Malik



4 etape de difuzie
(20 iteratii) si fuziune



Rezultate experimentale



Imagine
originala



Rezultat
Perona
Malik



Rezultat
CED



Rezultat
obtinut prin
metoda
propusa

Concluzii si perspective

Concluzii

- Cadrul propus nu impune limitari asupra tipurilor de filtre ale caror efecte se doresc a fi combinate
- Combinarea efectelor filtrelor se face prin fuziune la nivel de rezultate si nu prin combinatii liniare locale

Perspective

- Dezvoltarea de reguli de fuziune elaborate tinand cont de constrangeri geometrice
- Studiarea influentei numarului nivelelor de descompunere asupra calitatii rezultatelor
- Utilizarea de tehnici de fuziune in domeniul transformatelor wavelet