XIX.A.269 Оценивание параметров объектов в дистанционных исследованиях

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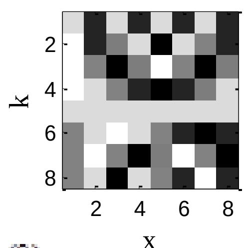
The image is associated with its vector gradient field. The analysis of vector fields with the help of single-length vector templates made it possible to localize (indicate) object in the image by calculating the main parameters of the object: position and size. The proposed method of indicating local objects using gradient fields turned out to be highly precision and noise-immunity.

1D FDST in mathematical analysis

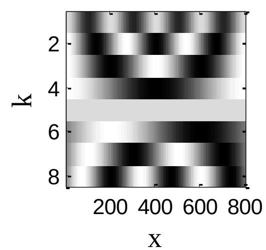
Theorem (Terentiev): 3 objects are given: an array (row) of samples ***D=f(x0)*** and two matrices: Fourier harmonics $H^{(0)}(x0)$, $x0=0 : N\text{-}1$ и $H^{(n)}(x)$, $x=0 : dx : N\text{-}dx$, then the "continuous" function $dx<1$ $\boldsymbol{f^{(n)}(x)=(H^{(0)}(x0)*D')'*H^{(n)}(x)}$ for n = 0 passes through the samples points ***D=f (x0).***

Fourier harmonics



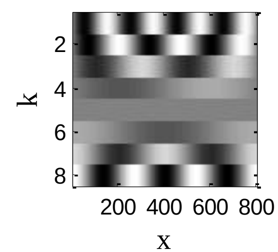
$H^{(0)}(x0), N=8, dx=1$

Interpolation



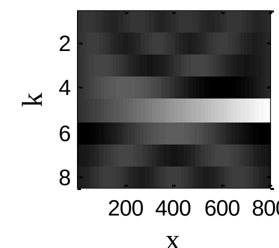
$H^{(0)}(x), N=8, dx=0.01$

Differentiation



$H^{(1)}(x), N=8, dx=0.01$

Integration



$H^{(-1)}(x), N=8, dx=0.01$

In $\boldsymbol{f^{(n)}(x)}$ the first asterisk implements the direct Fourier Transform with harmonics $H^{(0)}(x0)$, $dx=1$ and the second asterisk implements the inverse FT with $H^{(n)}(x)$, $dx<1$.

For n> 0, we realize the n-th order derivative, and for n <0, the –n order integral with the result in the form of an interpolated "continuous" function with digitization step $dx<1$.

3D FDST in field theory operations

Theorem (Terentiev): 3 objects are given: an array of samples $D=f(x0,y0, z0)$, the matrices are the Fourier harmonics $H^{(0)}(x0)$, $x0=0 : N-1$ and $H^{(n)}(x)$, $x=0 : dx : N-dx$, then the "continuous" function (dx <1)

$$f^{(nx,ny,nz)}(x,y,z)=\sum_{kx,ky,kz=1}^{N} c_{kx,ky,kz} * H^{(nx)}(kx,x) * H^{(ny)}(ky,y) * H^{(nz)}(kz,z), \quad (1)$$

$$c_{kxkykz}=(f(x0,y0,z0), H^{(0)}(kx,x0) * H^{(0)}(ky,y0) * H^{(0)}(kz,z0))=$$

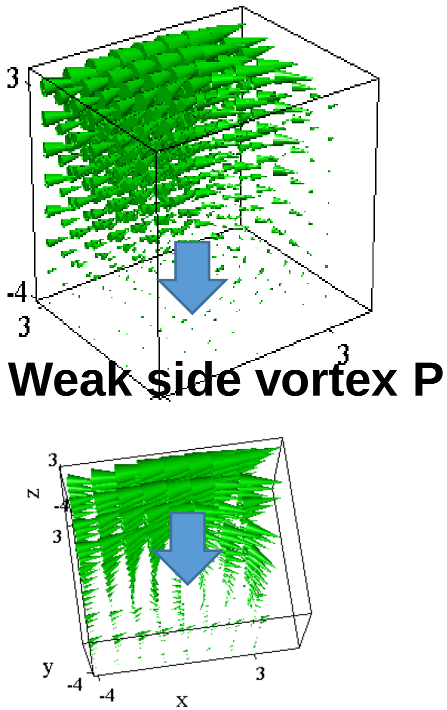
$$=\sum_{x0,y0,z0=1}^{N} f(x0,y0,z0) * H^{(0)}(kx,x0) * H^{(0)}(ky,y0) * H^{(0)}(kz,z0),\ \ kx,ky,kz=1:N. \quad (2)$$

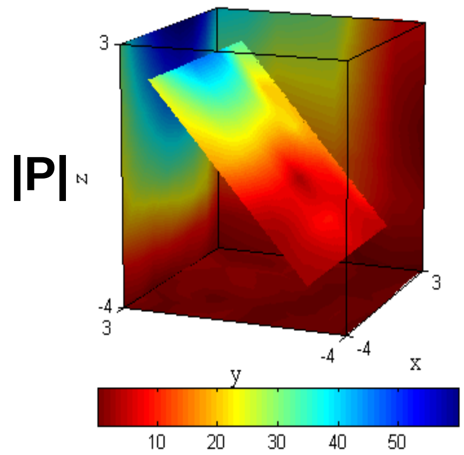
passes through sampling points $f^{(nx,ny,nz)}(x0, y0, z0)$.

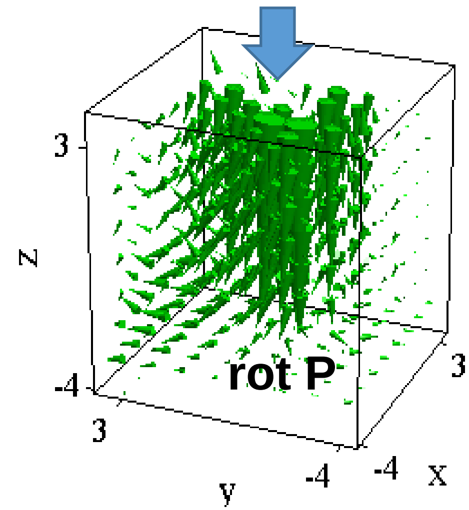
Scalar products (2) are realized by direct FT, and the Fourier series (1) is realized by "invers FT" with interpolation if dx <1.
The gradient of the array of numbers $D=f(x0,y0,z0)$:

$$grad\ D(x,y,z)=\{\frac{\partial}{\partial x}D, \frac{\partial}{\partial y}D, \frac{\partial}{\partial z}D,\}=\{f^{(1,0,0)}(x,y,z),\ f^{(0,1,0)}(x,y,z),\ f^{(0,0,1)}(x,y,z)\}$$

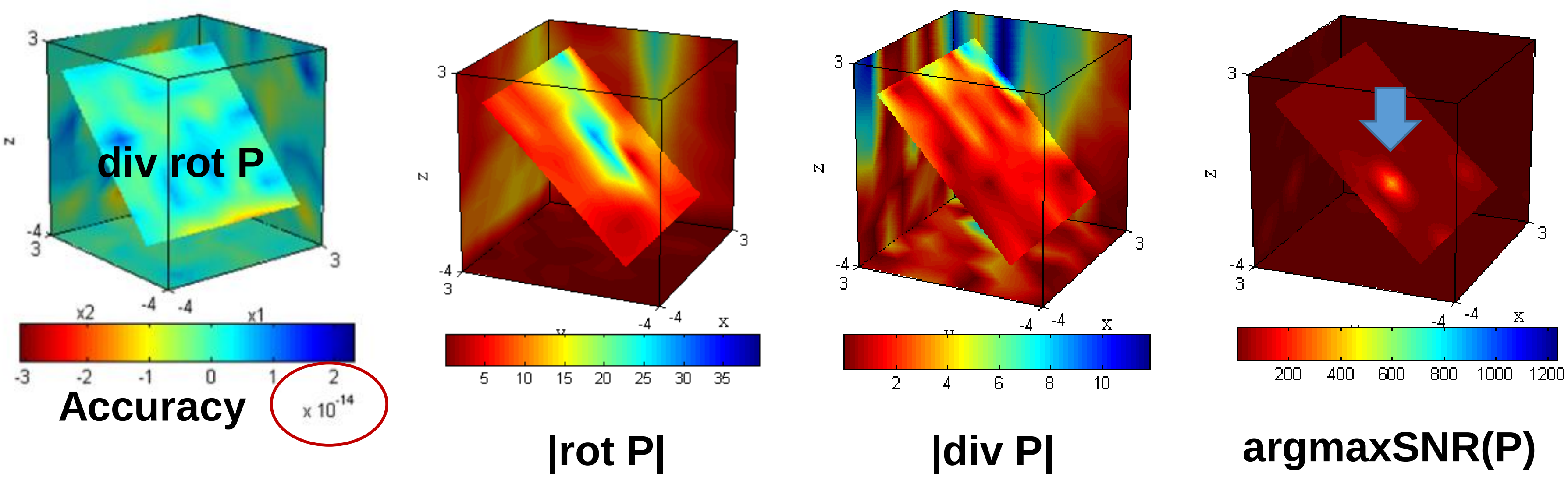
Localization of the vortex with its axis of rotation



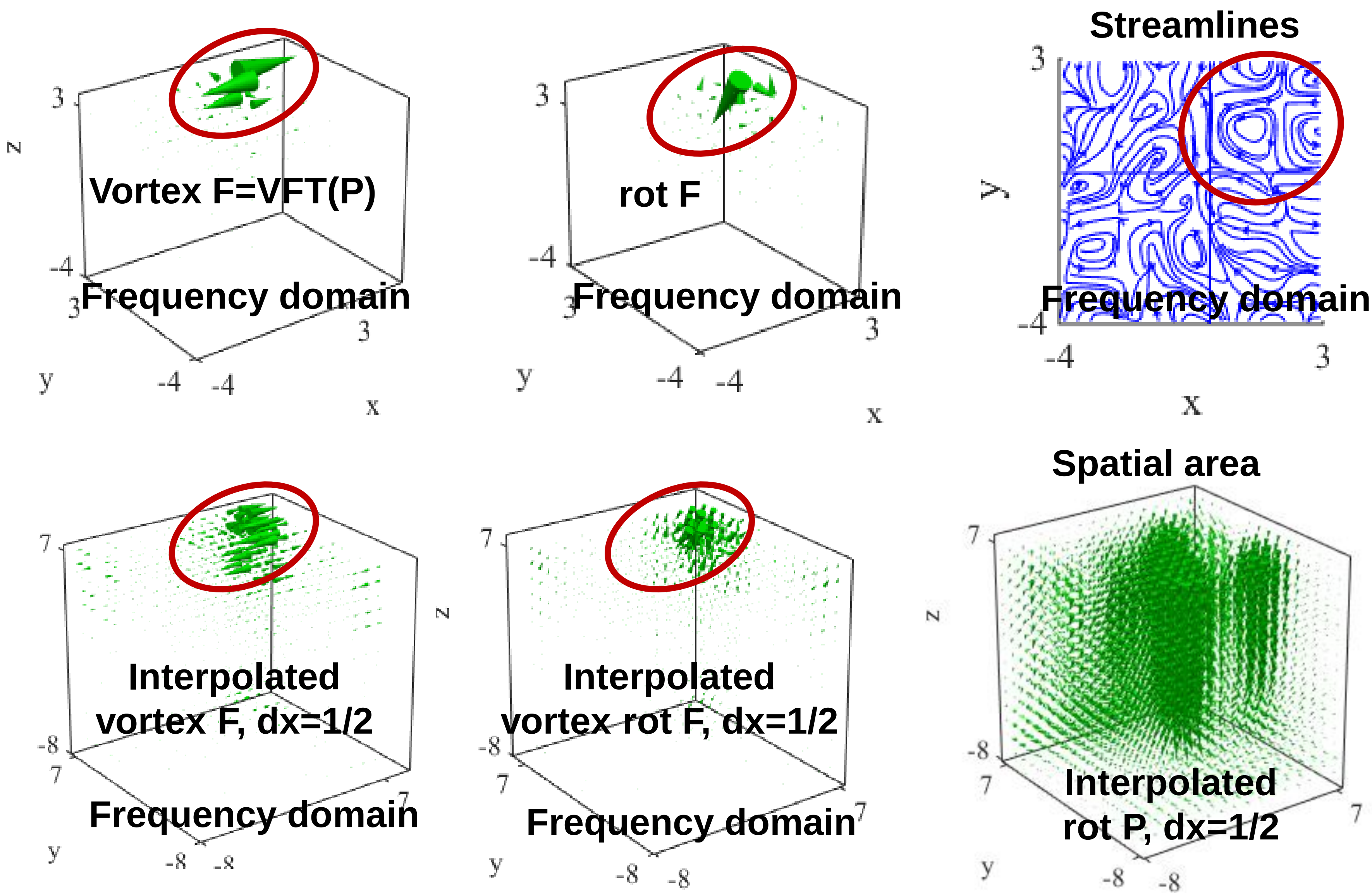




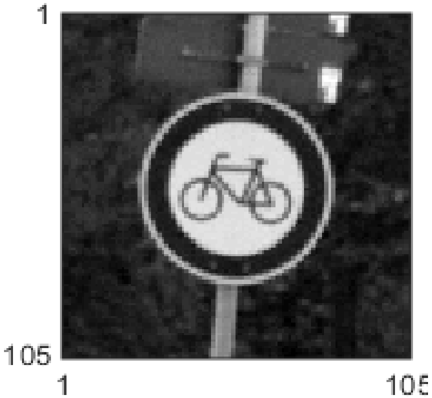
SNR(P)=|rot P|/|div P|



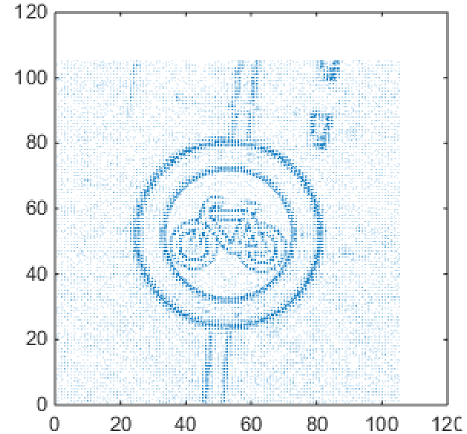
Interpolations and vortices in the frequency domain



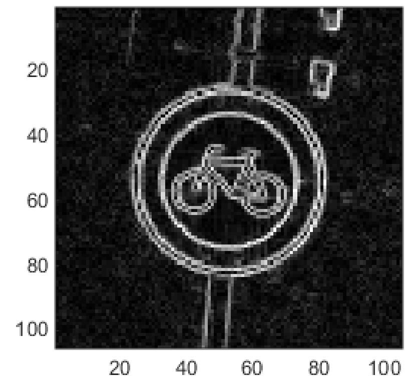
The main the concepts



B fragment - TS in blue



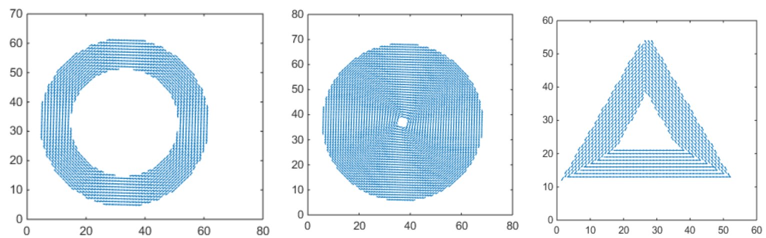
gB=grad B

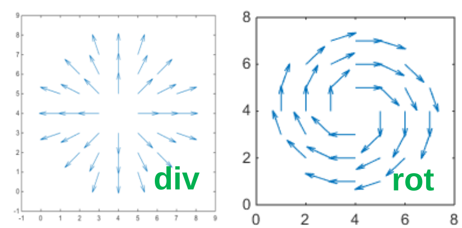


|gB|=|ogB|

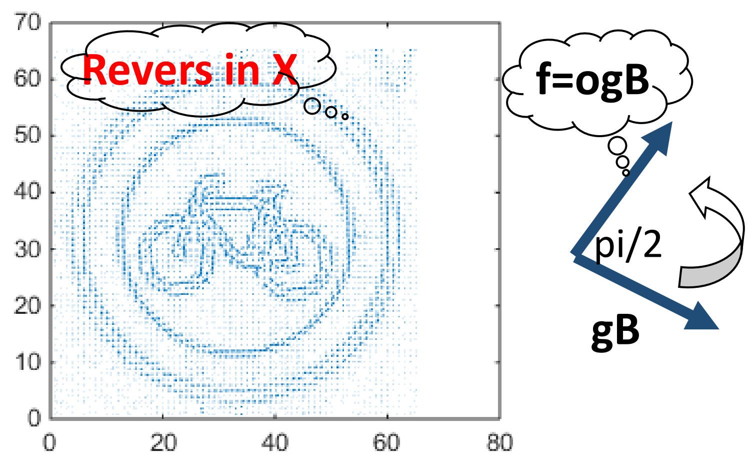
$SNR(f|X)=[fc]^2/[fs]^2$

$aSNR(f|X)=atan2([fc],[fs])$

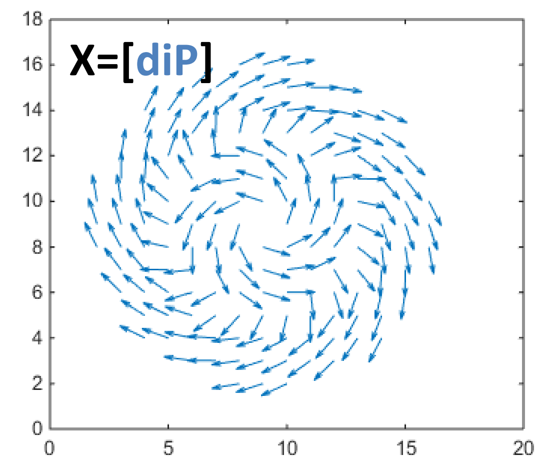

Templates X=[diC] , [diT], [diR]

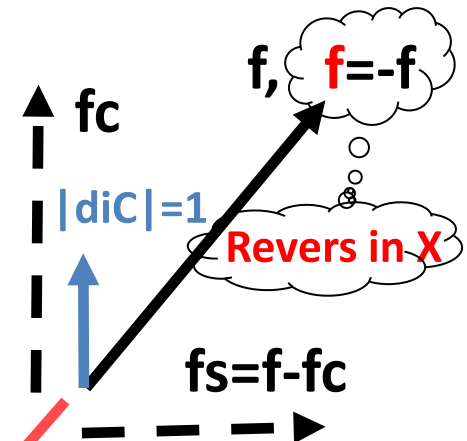


Projections fc and fs on diC direction, X=[diC]



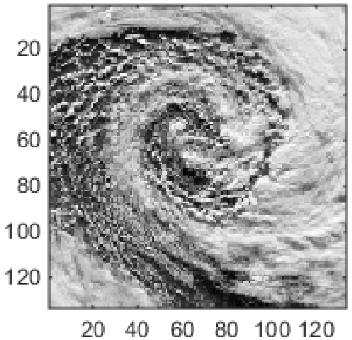
ogB is the rotation of gB on pi/2



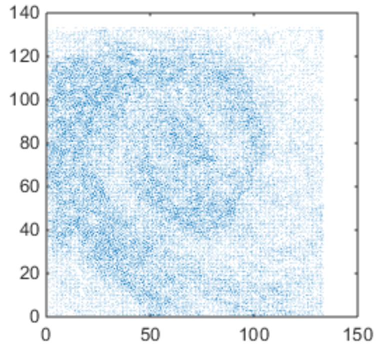


Object coordinates (xo, yo) = argmaxSNR (f|X), by (x, y) from S - scanning area by template X

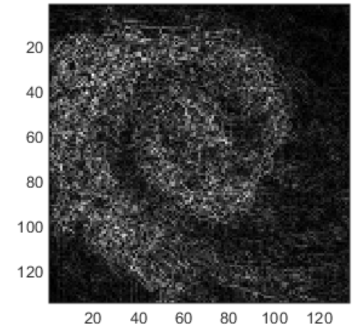
Vortices in space images



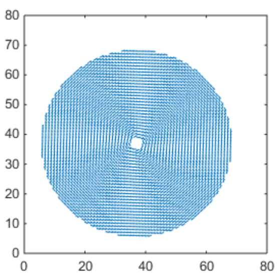
Vortex B



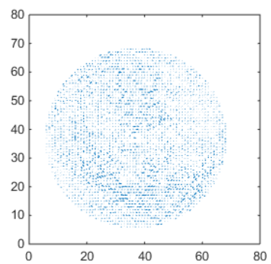
gB=grad B, f=ogB



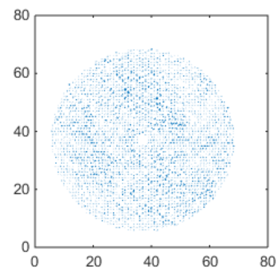
|gB|=|ogB|



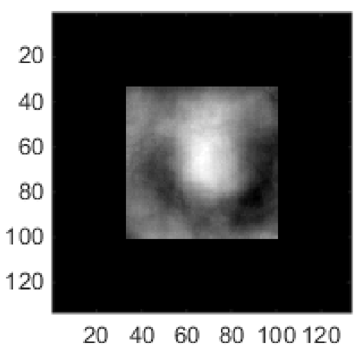
Template=[diC]



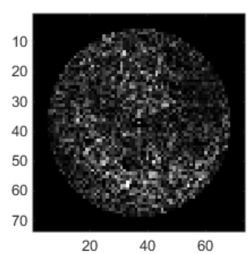
Signal fc



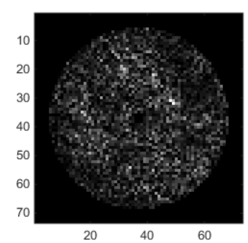
Noise fs



SNR(ogB|X) in S



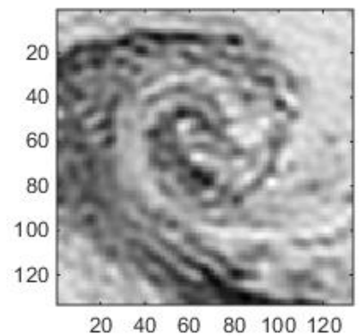
|fc|



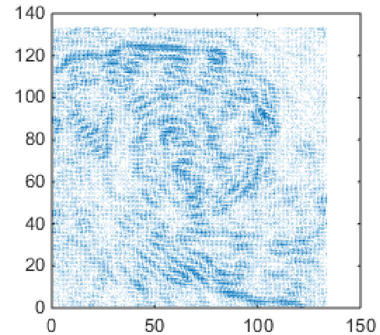
|fs||

In 100% frequency band

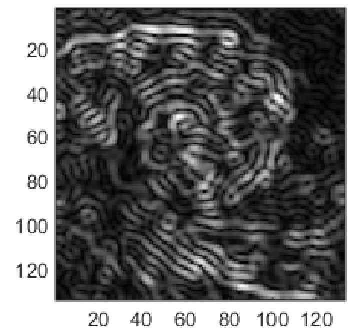
Vortices in space images



30% LF B

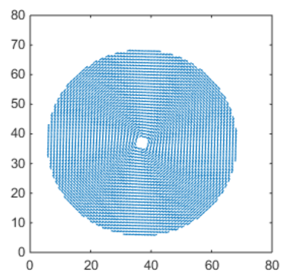


gB=grad B, f=ogB

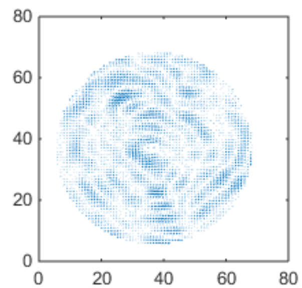


|gB|=|ogB|

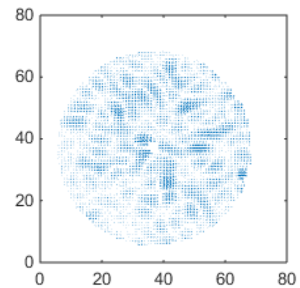
30% Low Frequency B



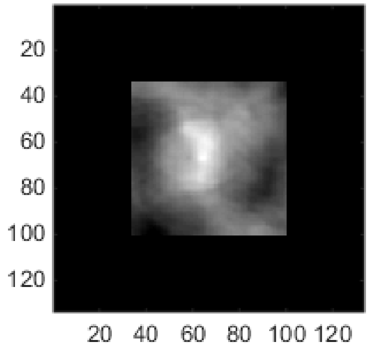
Template X=[diC]



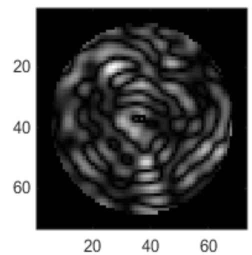
Signal fc



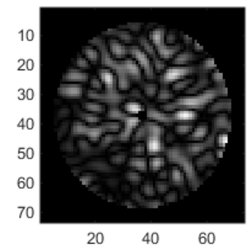
Noise fs



SNR(ogB|X) in S

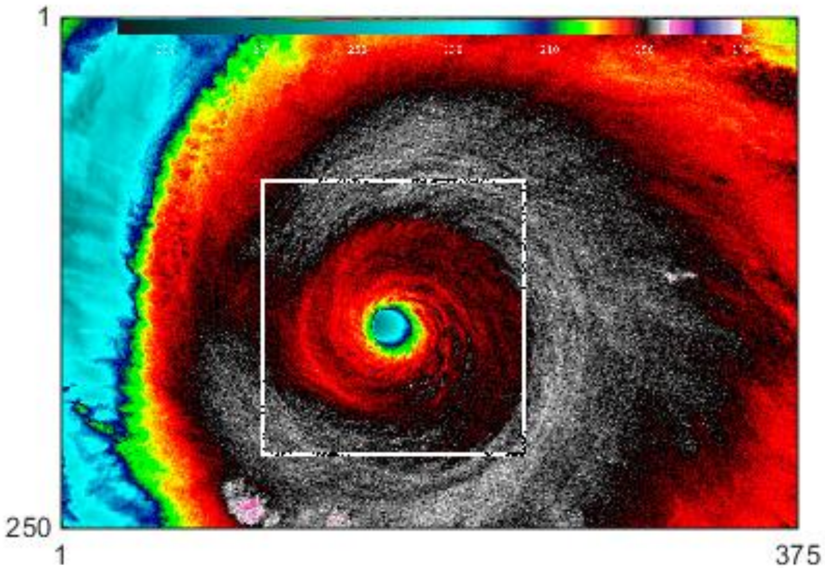


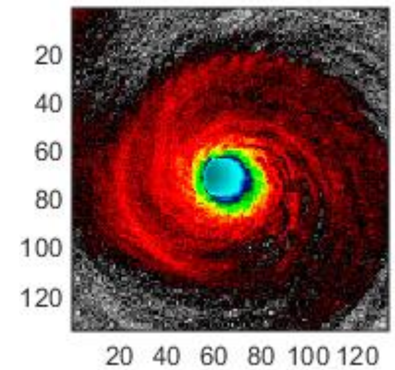
|fc|

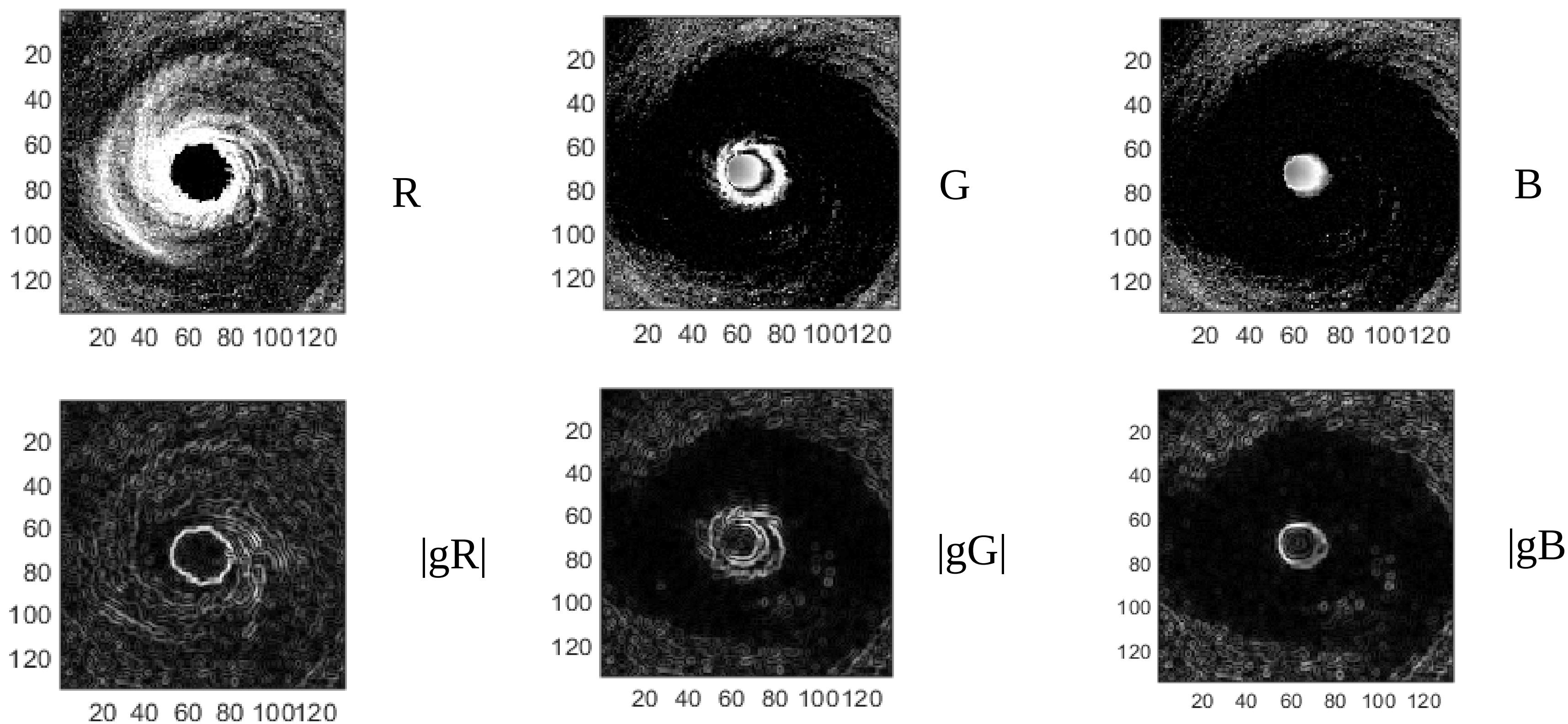


|fs|

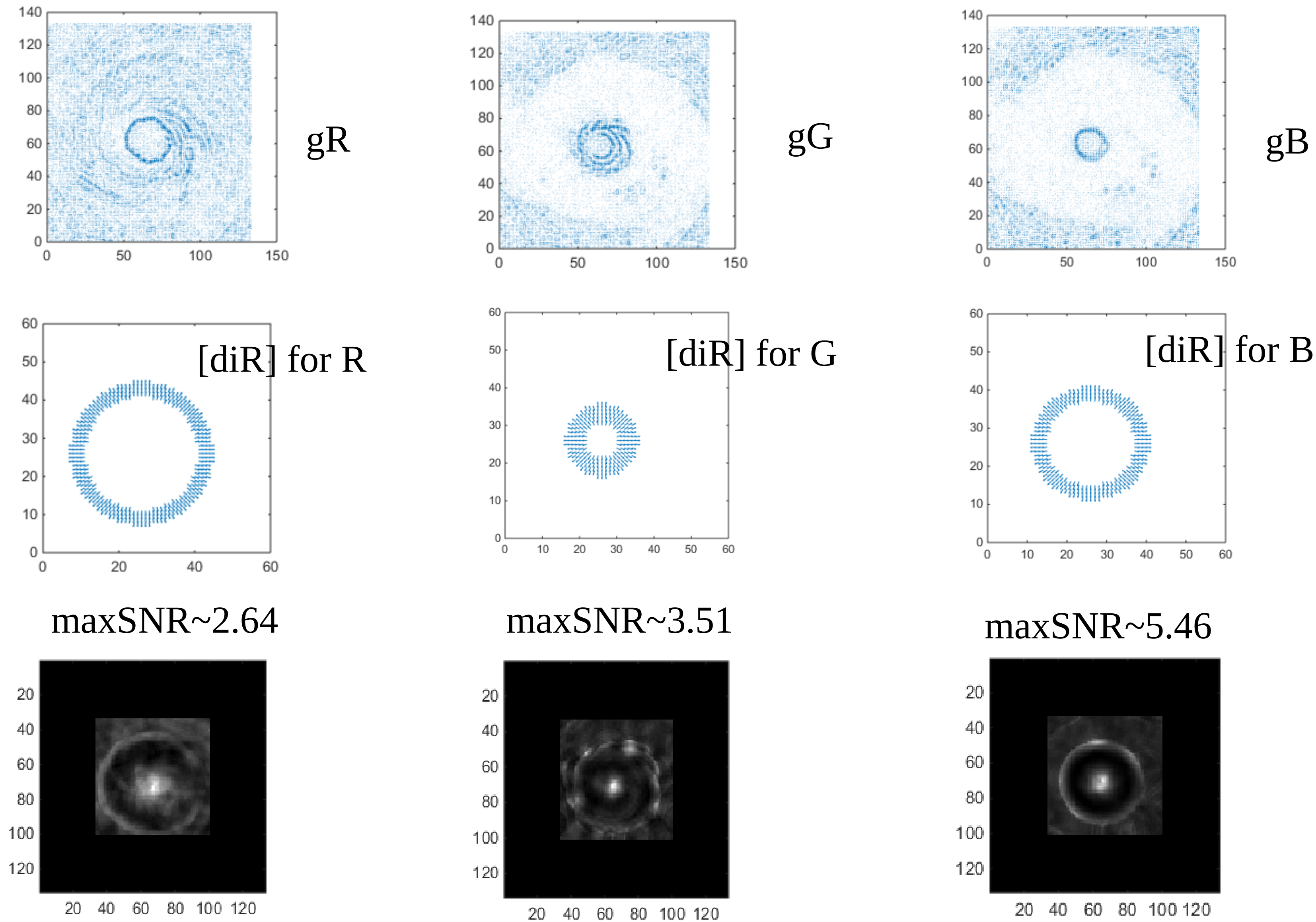
Vortices in IR space images



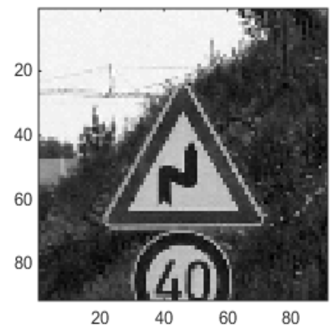




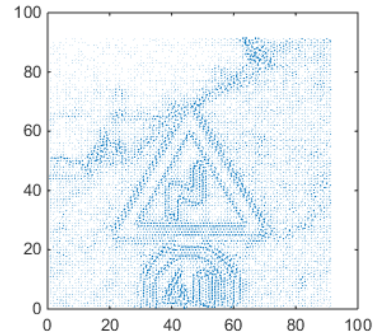
Parameters of vortices in IR space images



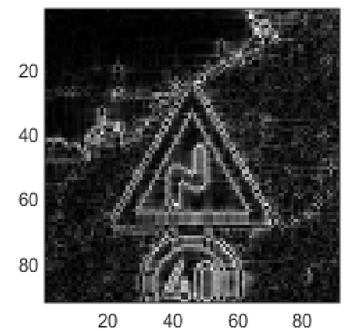
Localization of Traffic Signs



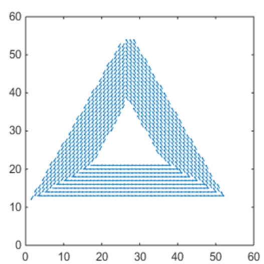
Fragment TS B



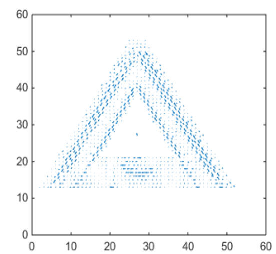
gB=grad B, f=ogB



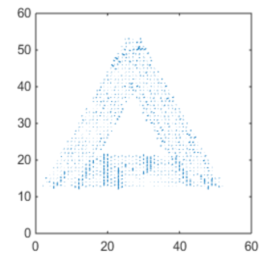
|gB|



Template X=[diT]

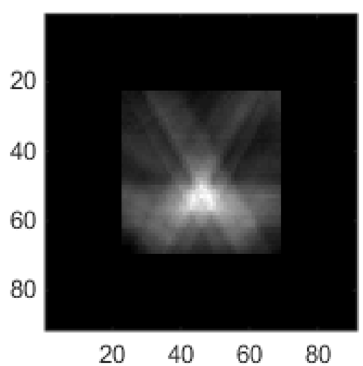


Signal fc

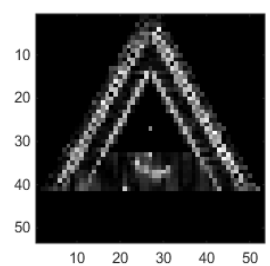


Noise fs

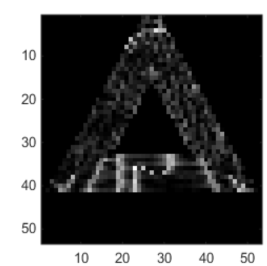
In 100% frequency band



SNR(f|X) in S

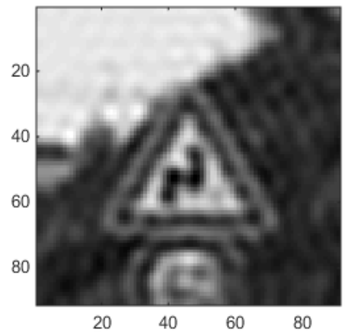


|fc|

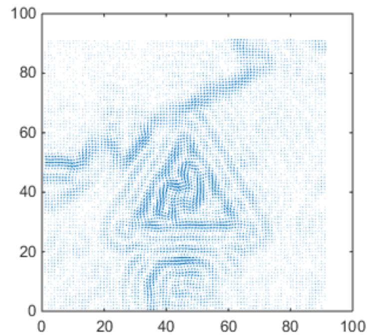


|fs|

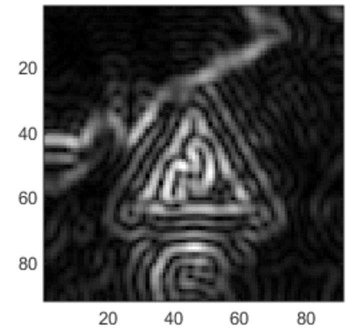
Localization of Traffic Signs



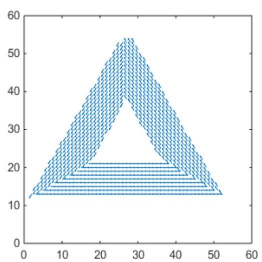
30% LF TS B



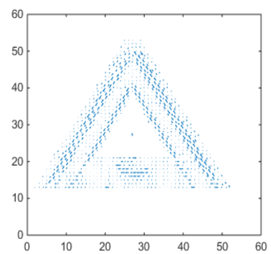
f=gB=grad B



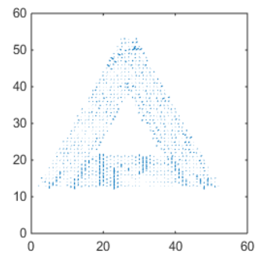
|gB|



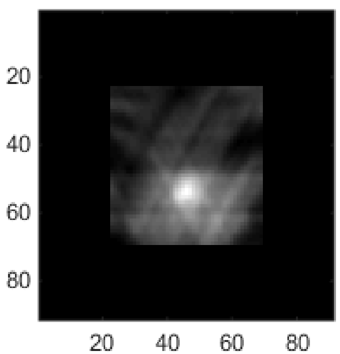
Template X=[diT]



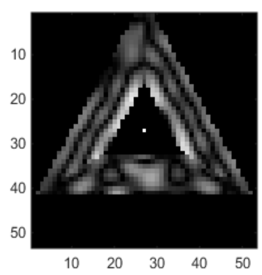
Signal fc



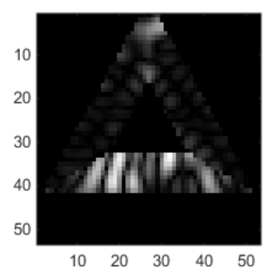
Noise fs



SNR(ogB|X) в S



|fc|

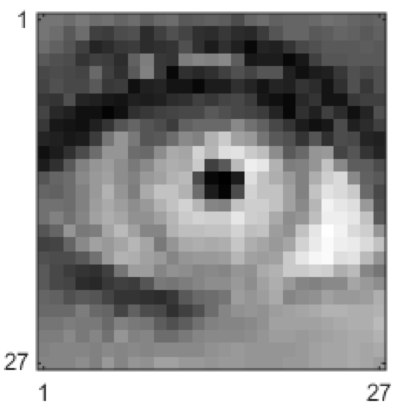


|fs|

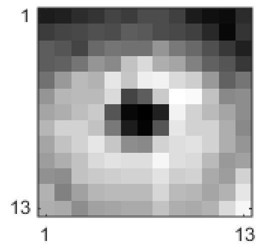
30% Low Frequency B

Pupil Eye size assessment

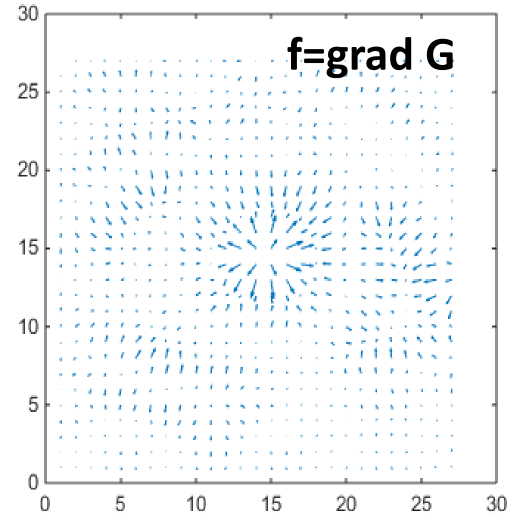
Results, left eye

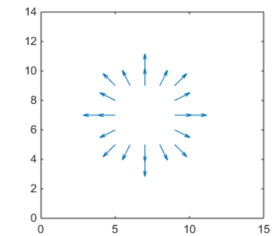


G

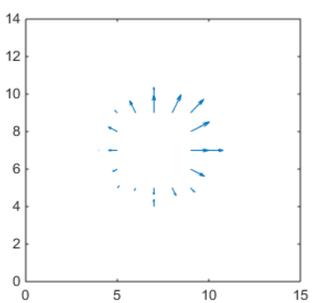


PE in X

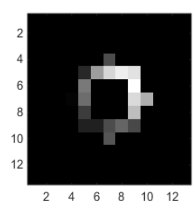




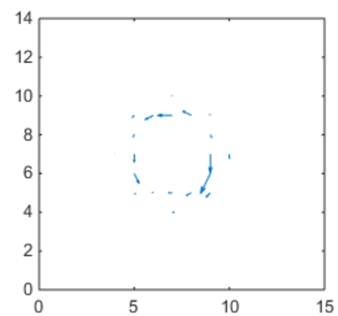
Template X=[diR]



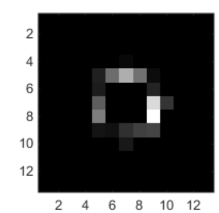
Signal fc



|fc|



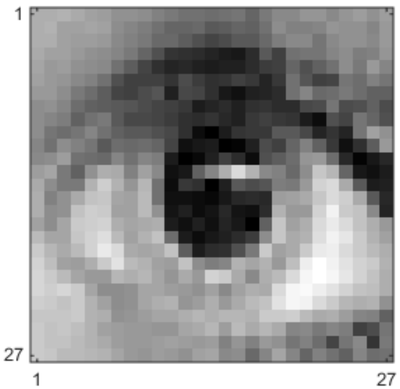
Noise fs



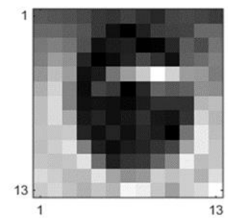
|fs|

Pupil Eye size assessment

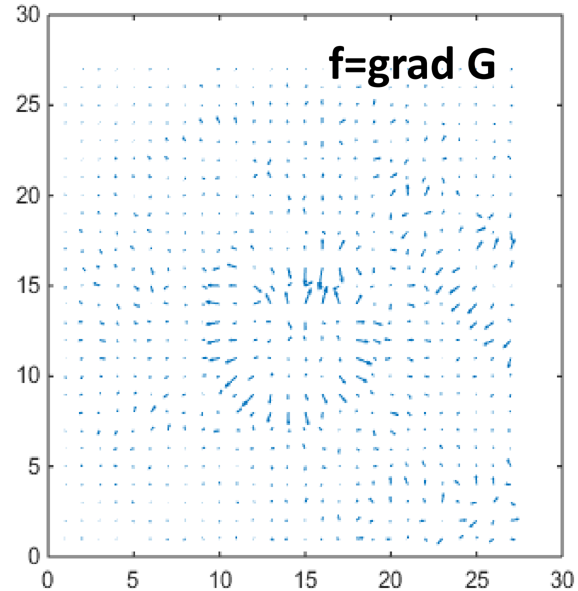
Results, right eye

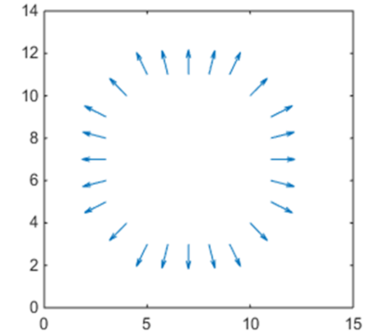


G

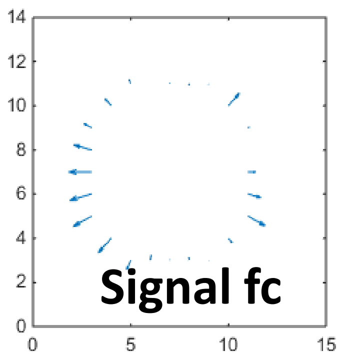


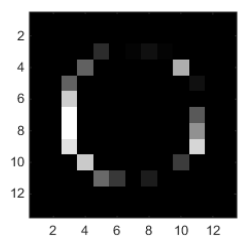
PE in X





Template X=[diR]





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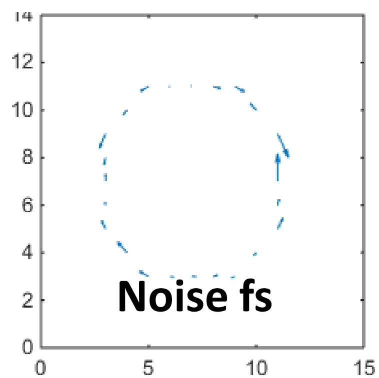

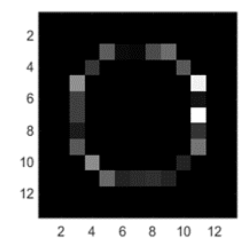

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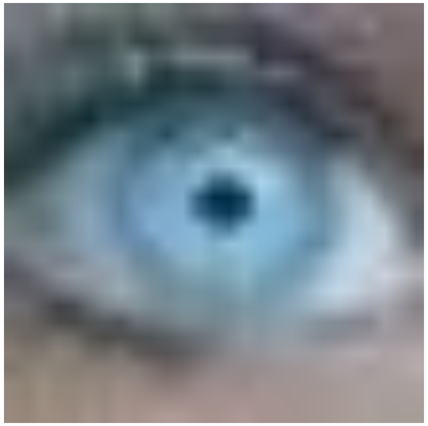
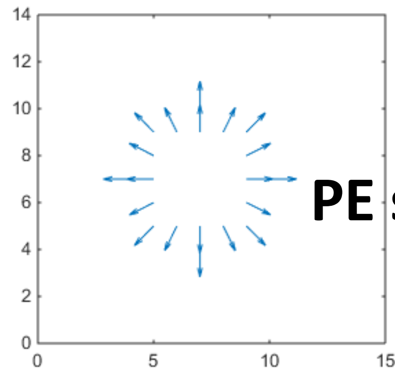
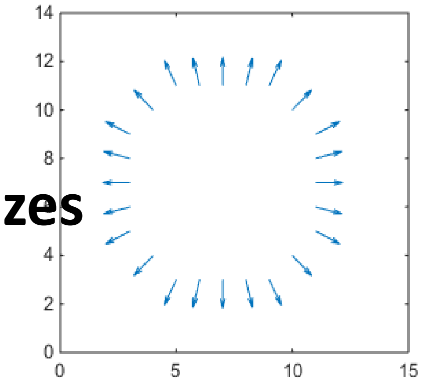
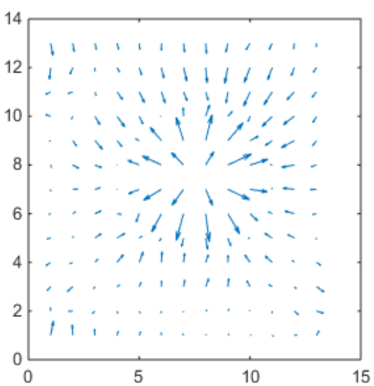
SNR and PE sizes for the left and right eyes

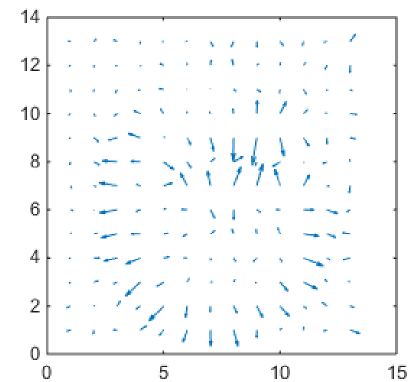




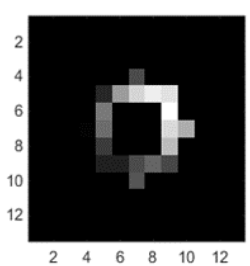
PE sizes

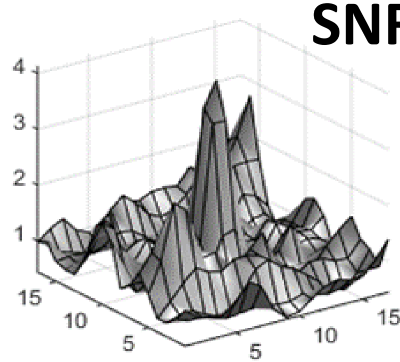




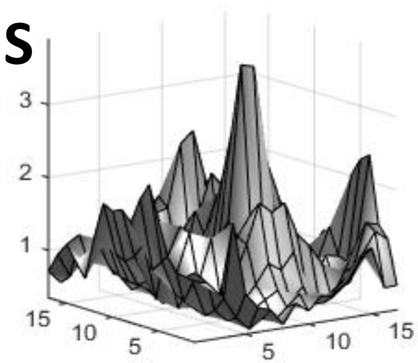


SNR in S

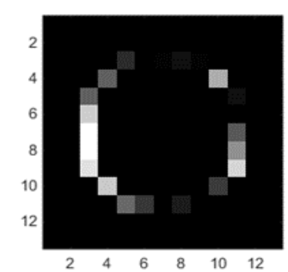




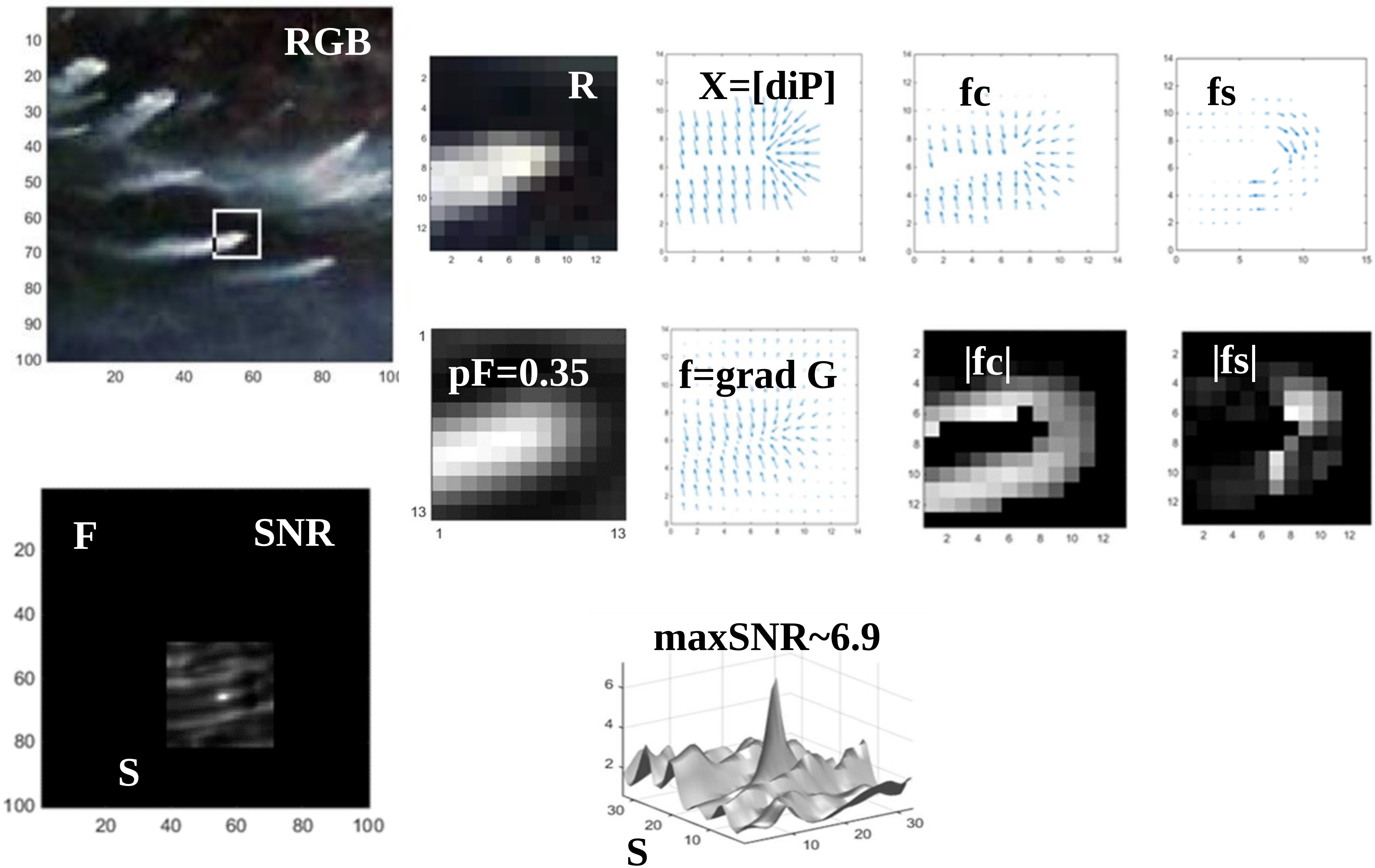
maxSNR~ **3.92**



maxSNR~ **3.71**



Localization of fires with smoke plumes in remote sensing



Conclusions

1. The ability to accurately assess the position of the Traffic Signs opens up new ways in solving the problem of semantic analysis of images such as “reading Traffic Signs” by the Navigator robot.
2. Assessing the exact distance between the Eye Pupils makes it possible to formulate new semantic tasks in evaluating parameters of the “Facial Features” type for implementing facial image recognition methods.
3. The plans of the problem of estimating the parameters of vortices in space images of the Earth with remote monitoring.
4. Our plans are to apply field theory operations in the analysis of neoplasms such as tumors, ulcers, metastases, etc. on 3D data in tomography.
5. Possible wide applications GMM in the production of processors.

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