

Восстановление сжатого ВИДЕО



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CS MSU Graphics & Media Lab*

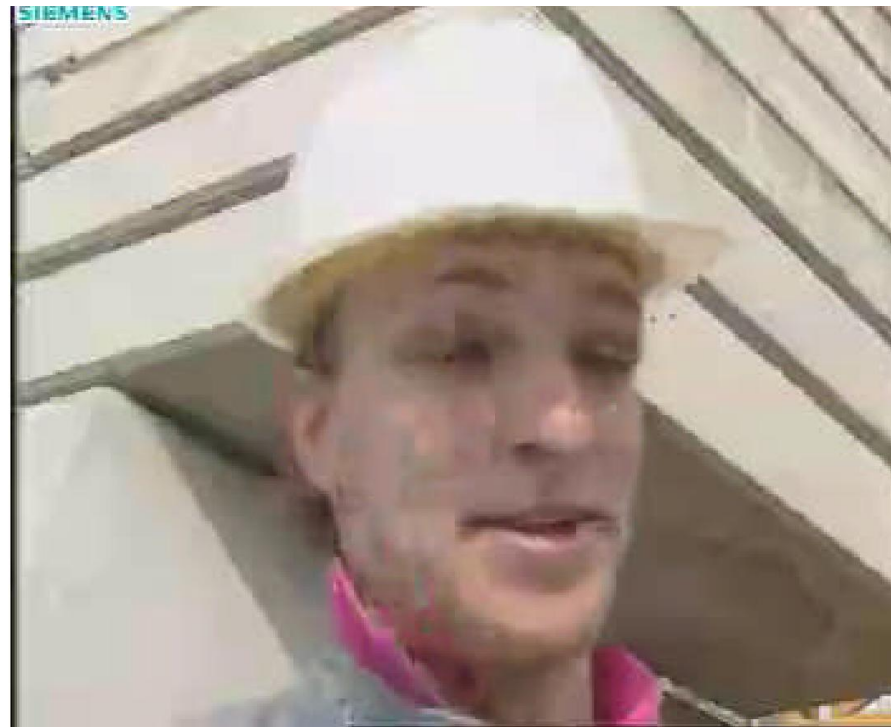


Содержание

- **Введение**
- SWAT
- Adaptive Fuzzy Filtering
- Заключение



Введение





Содержание

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- **SWAT**
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SWAT

$u \in R^{N \times 1}$ — исходное изображение

$G \in G^{N \times N}$ — ортонормированное преобразование

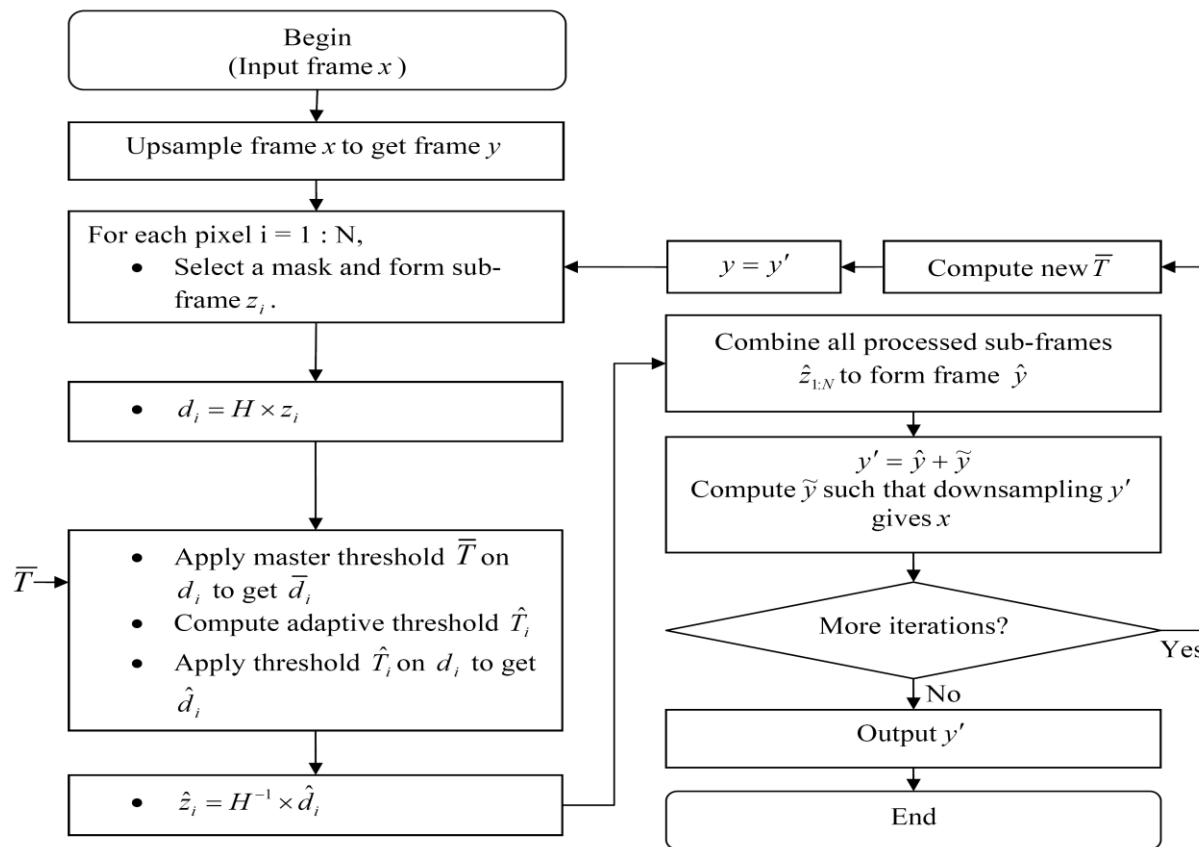
$c_i = g_i^T u$ — коэффициенты преобразования

$$u = \sum_{i=1}^N c_i g_i$$

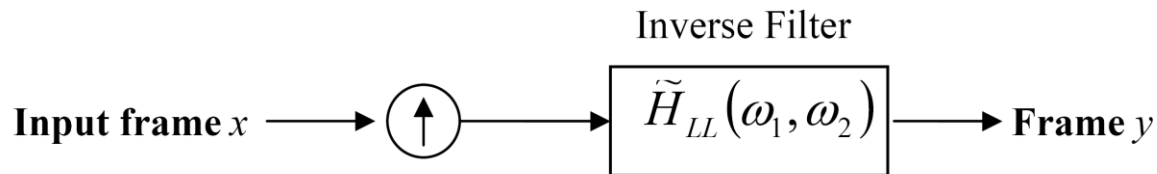
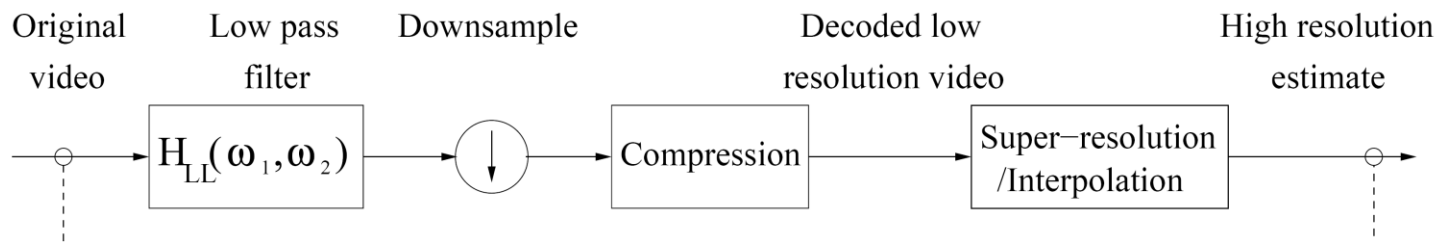
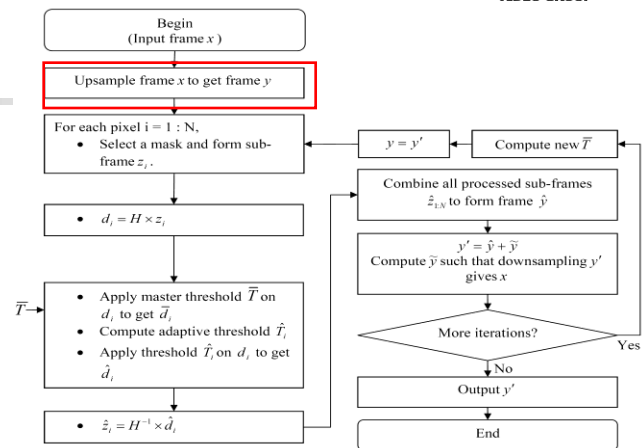
$$u = \sum_{i \in S(u, K)} c_i g_i + \sum_{i \notin S(u, K)} c_i g_i \approx \sum_{i \in S(u, K)} c_i g_i$$

$S(u, K)$ — K наибольших коэффициентов разложения

SWAT

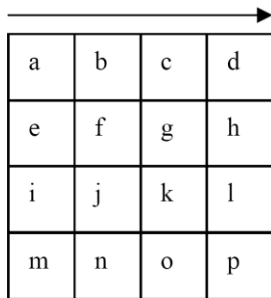
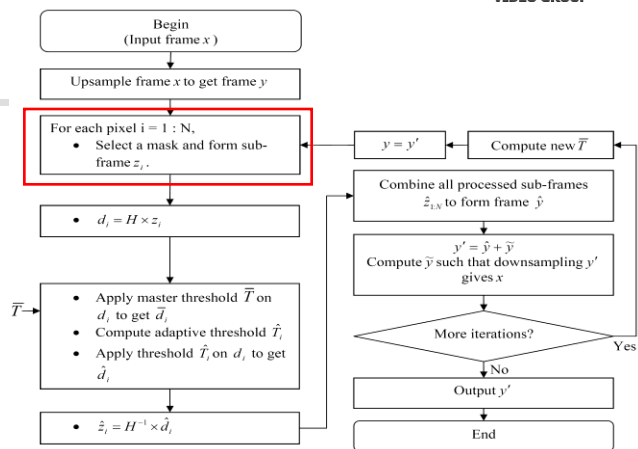


SWAT

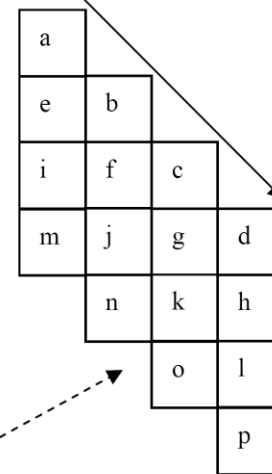
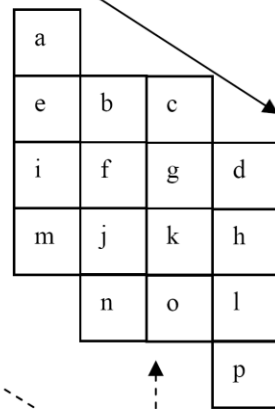
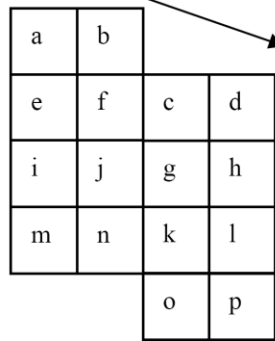


SWAT

- Изображение разбивается на блоки 4x4
- Для каждого блока выбирается подходящая маска



Regular



Directional

SWAT

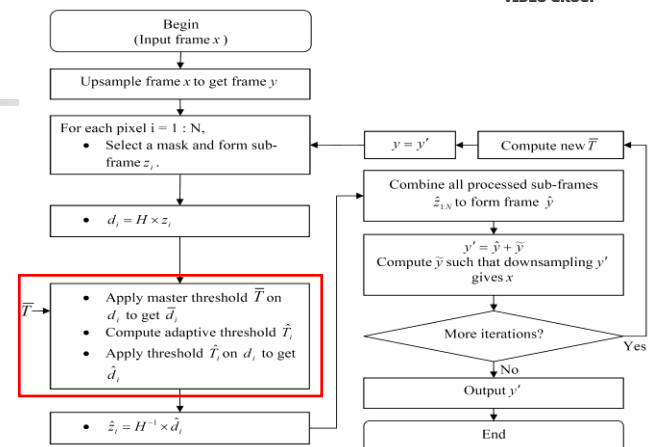
\bar{T} — главный порог

$$\bar{d}_i = \begin{cases} d_i, & |d_i| > \bar{T} \\ 0, & |d_i| \leq \bar{T} \end{cases}$$

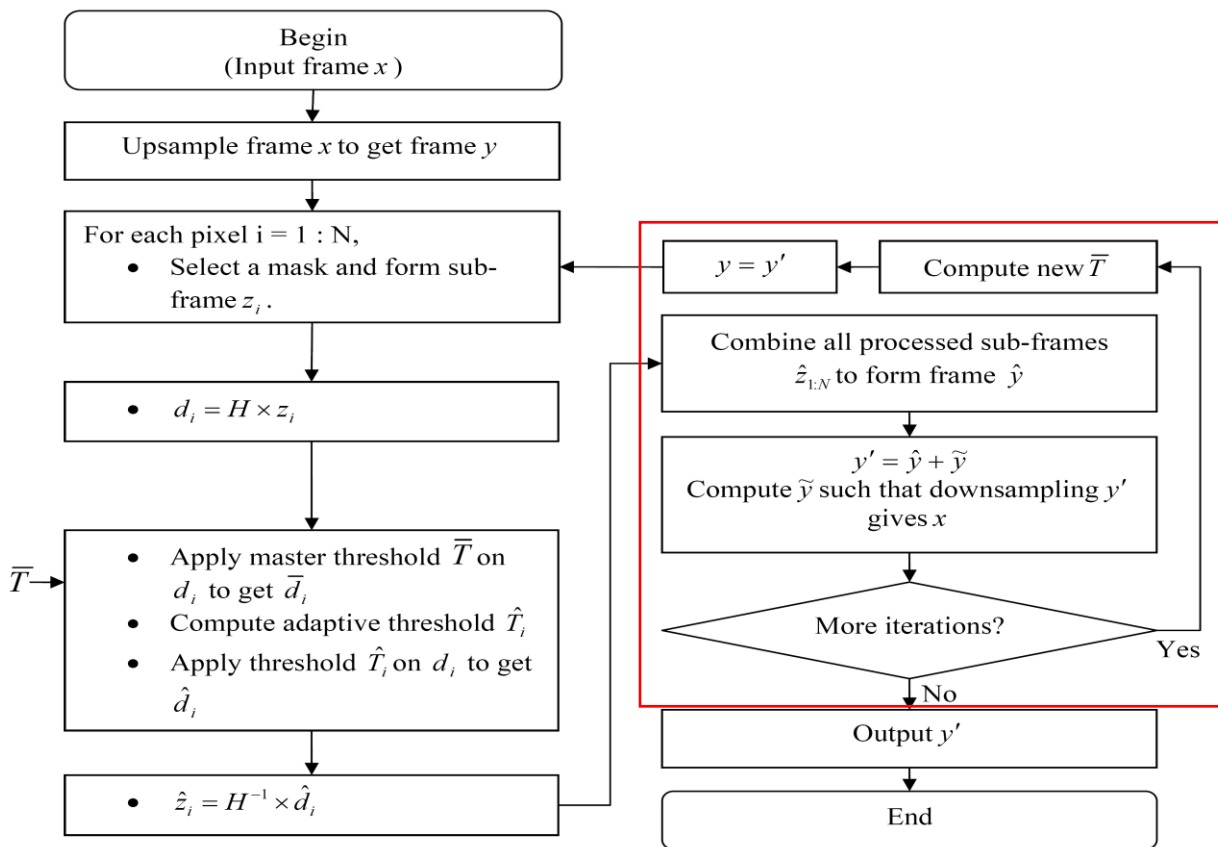
$$\hat{T}_i = \bar{T} \times f \left(\left\| d_i - \bar{d}_i \right\|_2^2 \right)$$

$$\hat{d}_i = \begin{cases} d_i, & |d_i| > \hat{T}_i \\ 0, & |d_i| \leq \hat{T}_i \end{cases}$$

$$f(0) = 1, f(\infty) = 0$$

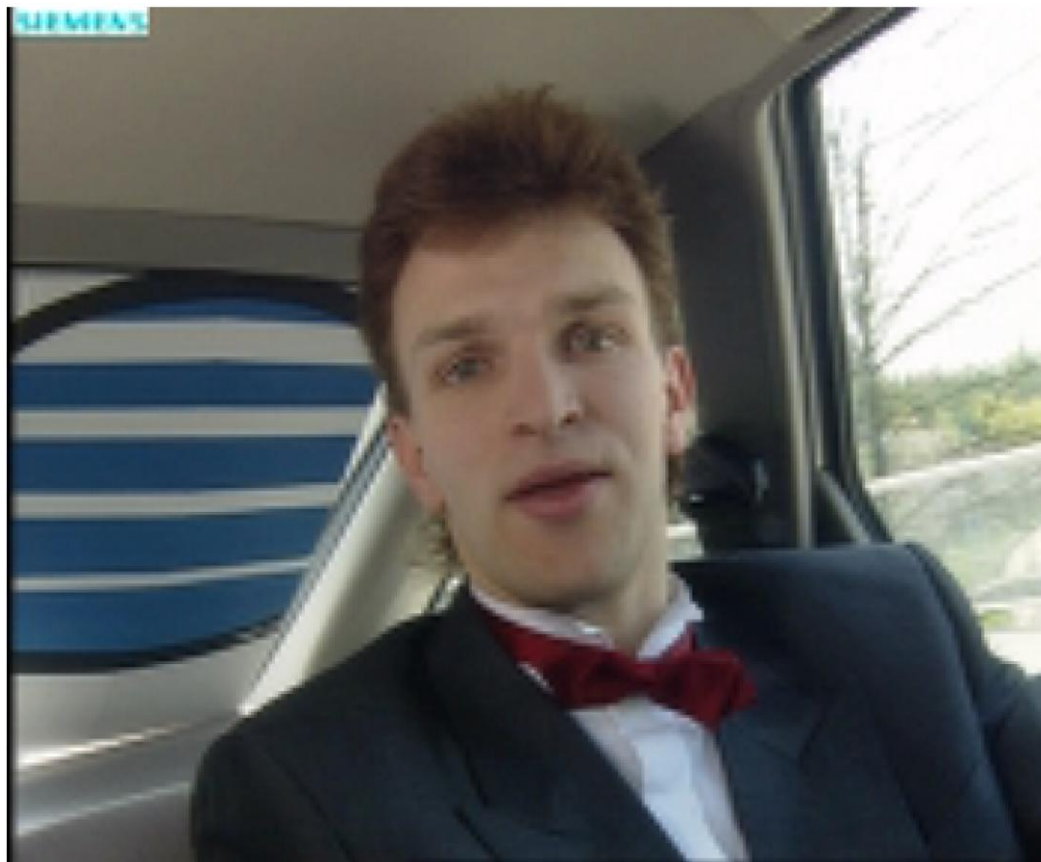


SWAT



SWAT

Результаты

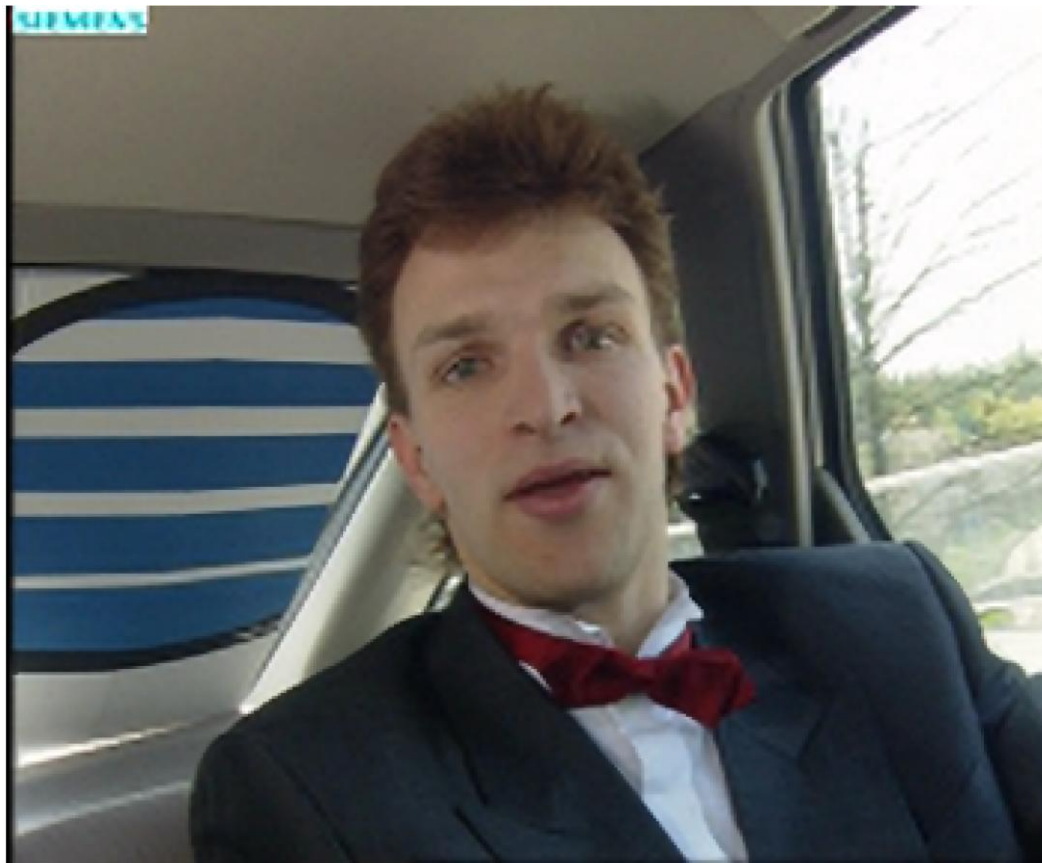


Билинейная интерполяция
(несжатое видео)

Fast super-resolution reconstructions of mobile video using warped transforms and adaptive thresholding, Sandeep Kanumuri, Onur G. Guleryuz, M. Reha Civanlar, SPIE Conf. on Applications of Digital Image Processing XXX, 2007

SWAT

Результаты

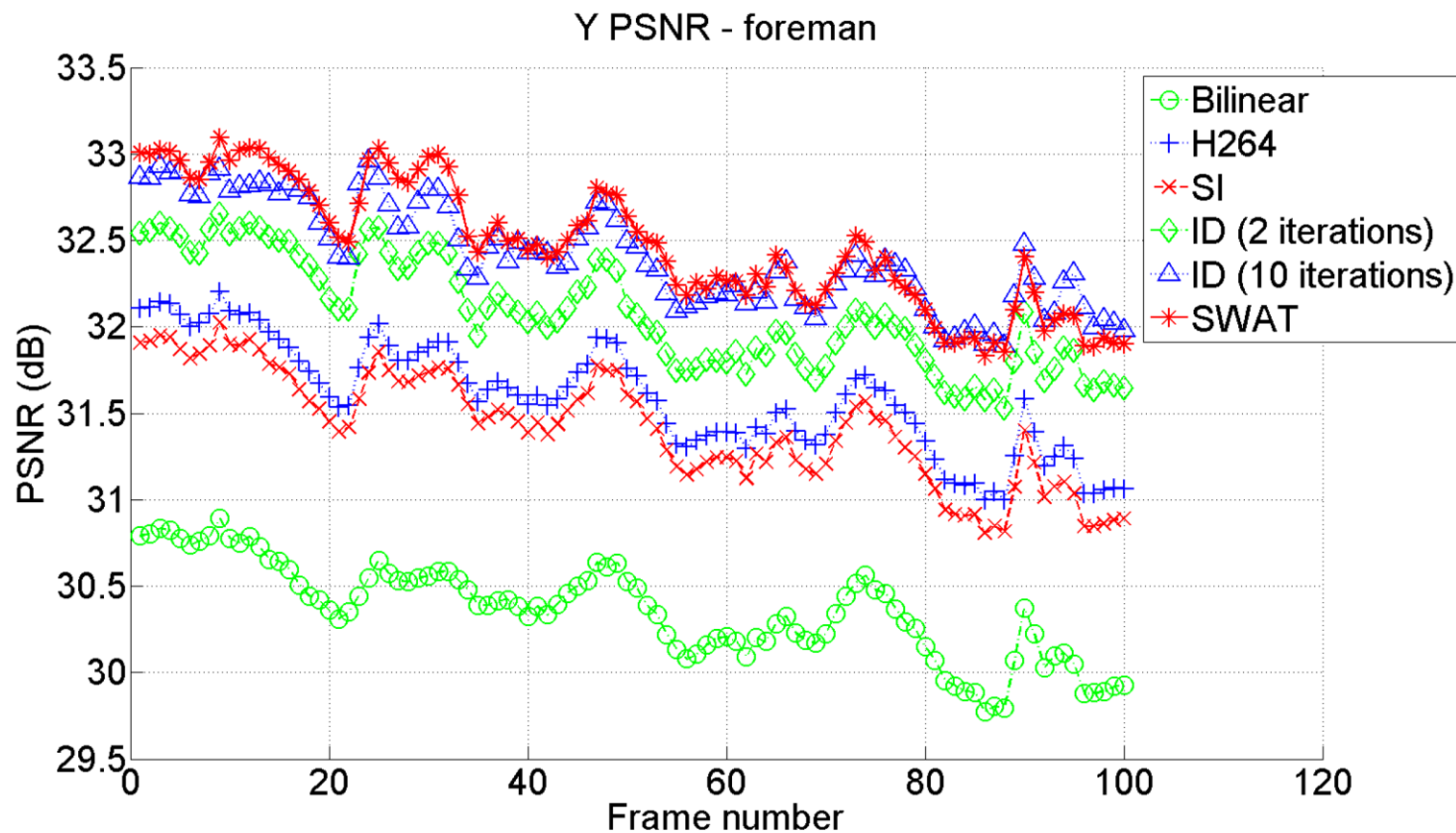


Результат обработки
(несжатое видео)

Fast super-resolution reconstructions of mobile video using warped transforms and adaptive thresholding, Sandeep Kanumuri, Onur G. Guleryuz, M. Reha Civanlar, SPIE Conf. on Applications of Digital Image Processing XXX, 2007

SWAT

Результаты

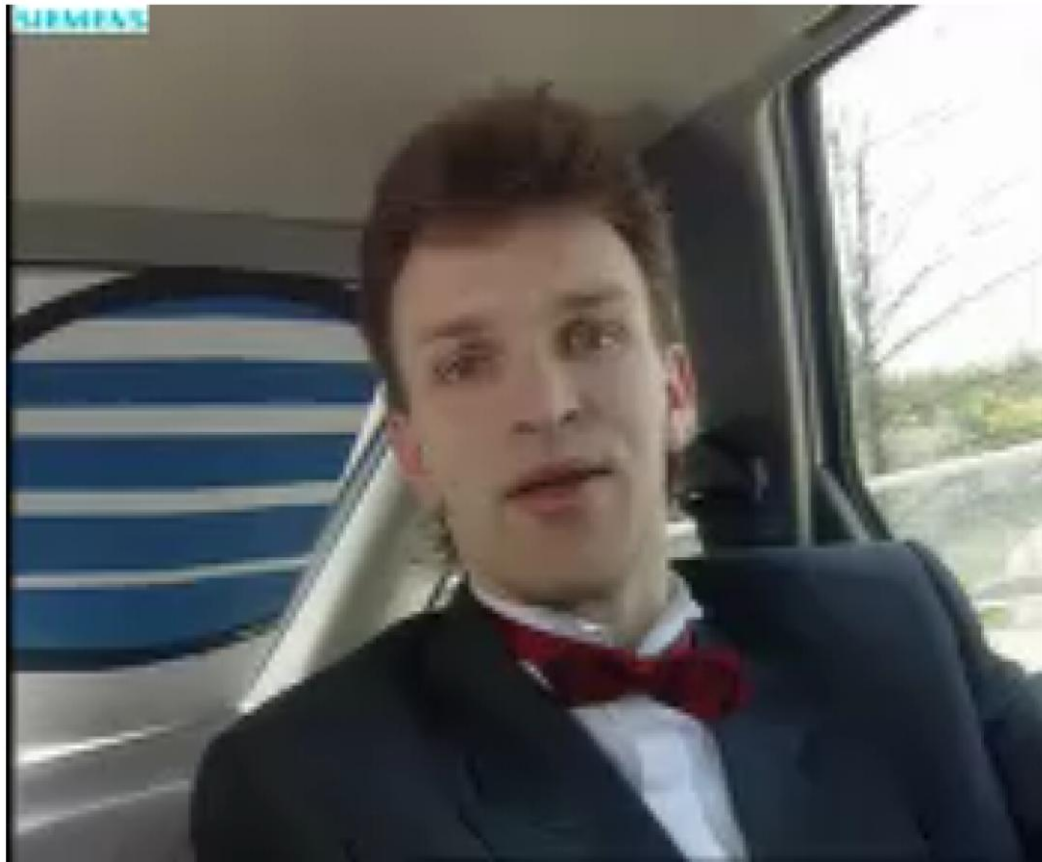


(несжатое видео)

Fast super-resolution reconstructions of mobile video using warped transforms and adaptive thresholding, Sandeep Kanumuri, Onur G. Guleryuz, M. Reha Civanlar, SPIE Conf. on Applications of Digital Image Processing XXX, 2007

SWAT

Результаты

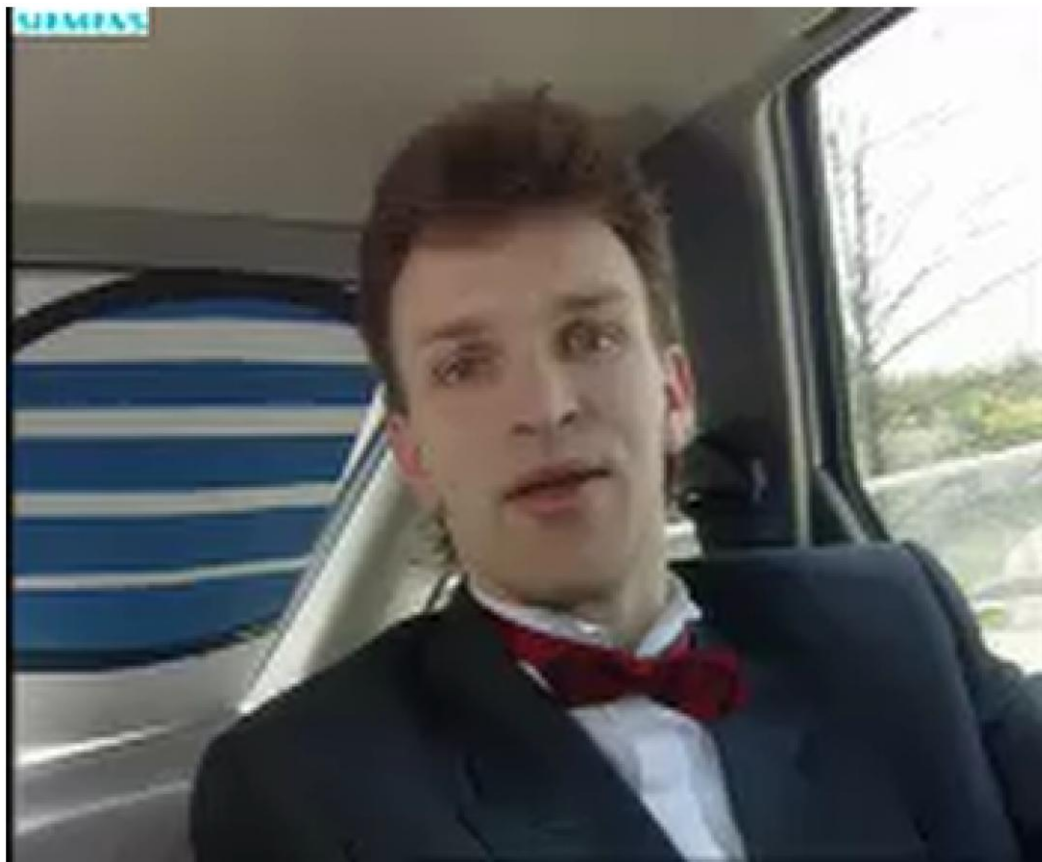


Сжатое видео (H.264, QP=25)

Fast super-resolution reconstructions of mobile video using warped transforms and adaptive thresholding, Sandeep Kanumuri, Onur G. Guleryuz, M. Reha Civanlar, SPIE Conf. on Applications of Digital Image Processing XXX, 2007

SWAT

Результаты

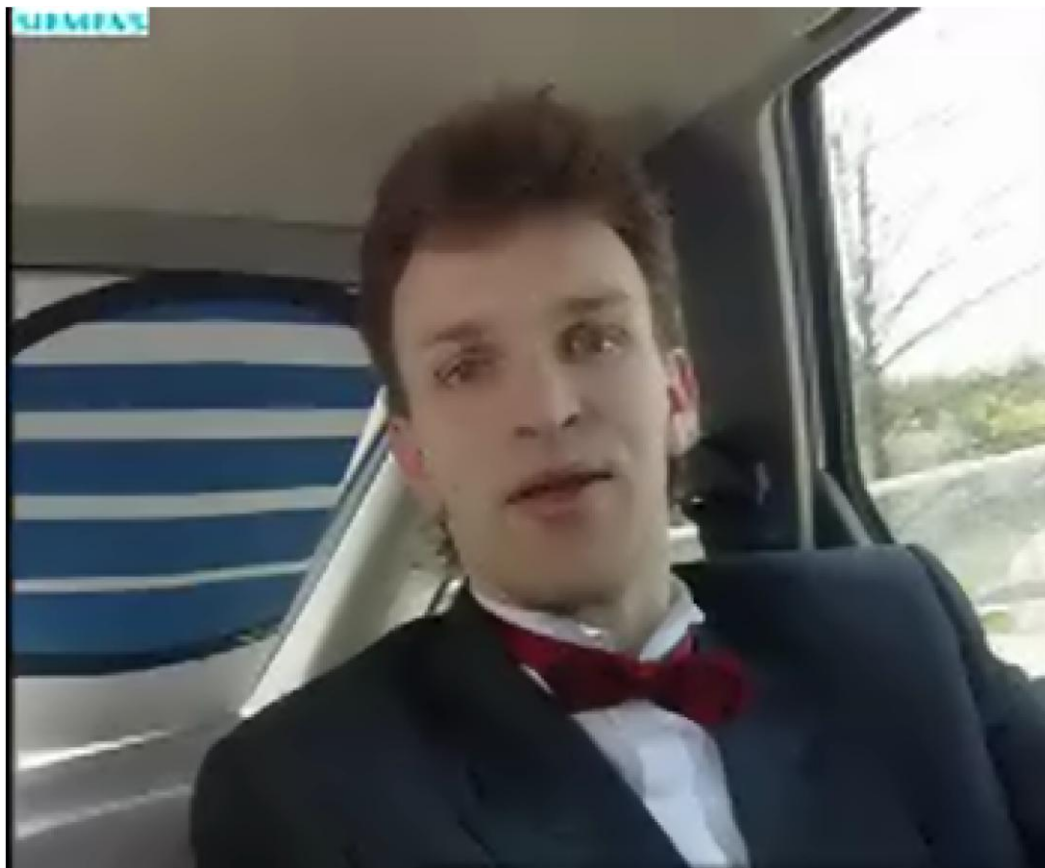


H.264 интерполяция

Fast super-resolution reconstructions of mobile video using warped transforms and adaptive thresholding, Sandeep Kanumuri, Onur G. Guleryuz, M. Reha Civanlar, SPIE Conf. on Applications of Digital Image Processing XXX, 2007

SWAT

Результаты



Предложенный метод

Fast super-resolution reconstructions of mobile video using warped transforms and adaptive thresholding, Sandeep Kanumuri, Onur G. Guleryuz, M. Reha Civanlar, SPIE Conf. on Applications of Digital Image Processing XXX, 2007

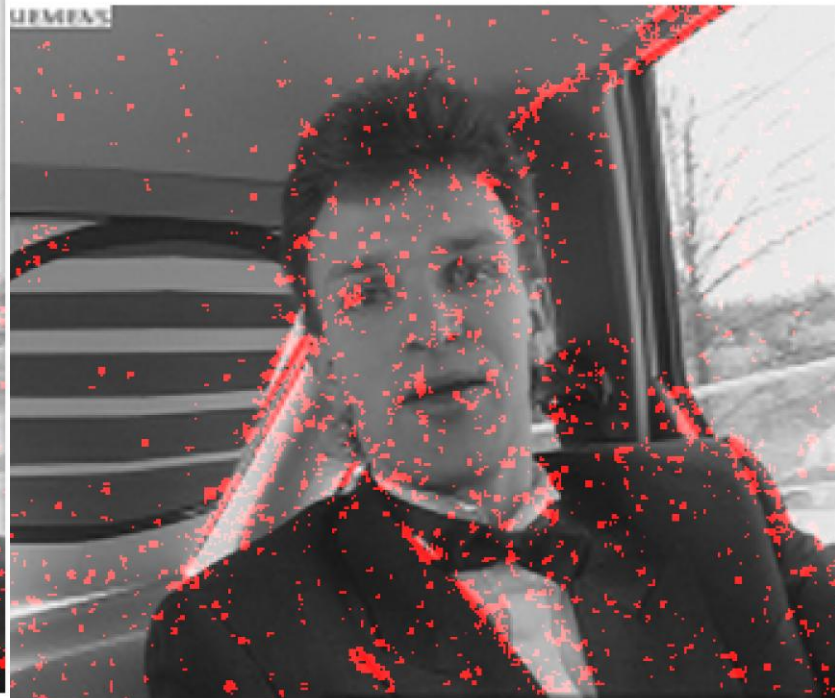
SWAT

Результаты

(a) 0.5dB improvement



(b) 1dB improvement

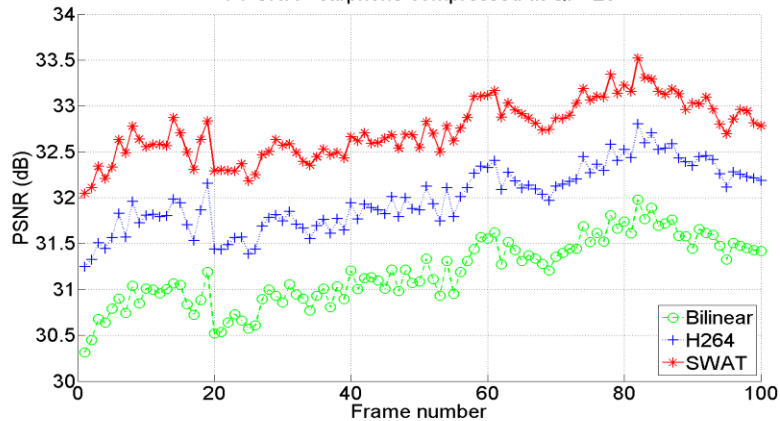


SWAT

Результаты

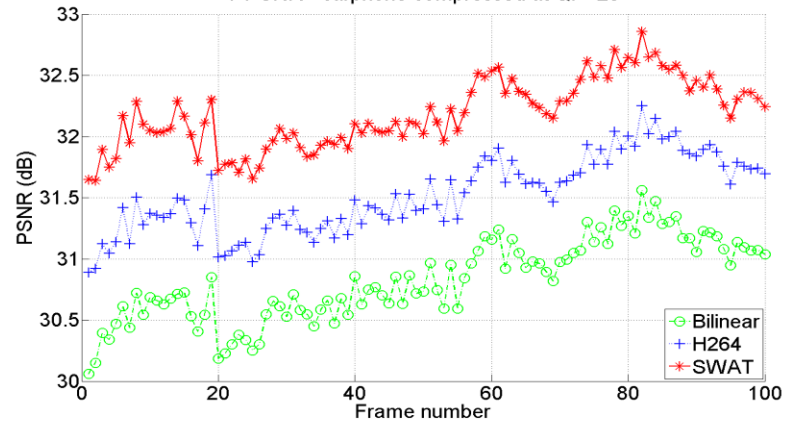
(a) QP = 20

Y PSNR - carphone compressed at QP=20

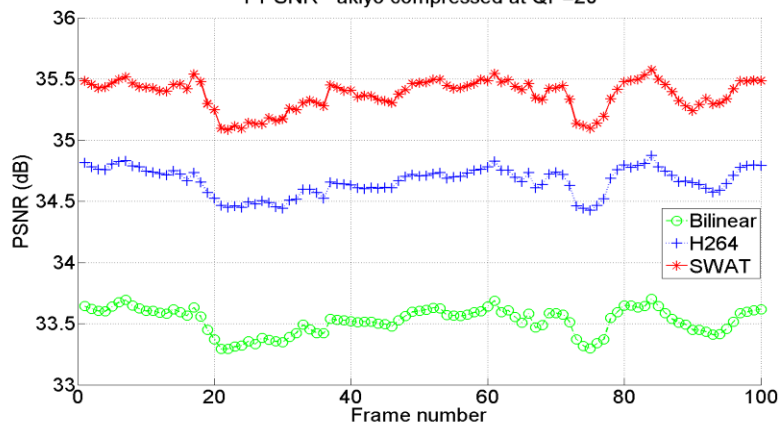


(b) QP = 25

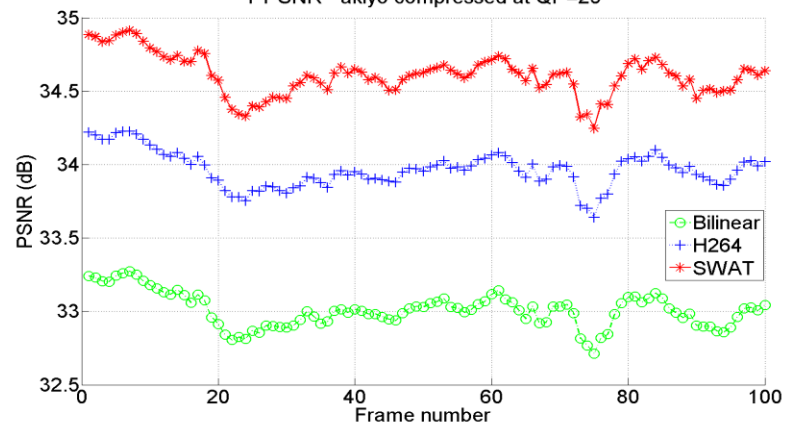
Y PSNR - carphone compressed at QP=25



Y PSNR - akiyo compressed at QP=20



Y PSNR - akiyo compressed at QP=25





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Adaptive Fuzzy Filtering

Обычный фильтр:

$$y[m, n] = \sum_{[m', n'] \in \Omega} h(x[m + m', n + n'], x[m, n]) \times x[m + m', n + n']$$

x — исходное изображение

y — результат

h — весовая функция

$$y[m, n] = \frac{\sum_{[m', n'] \in \Omega} h(x[m + m', n + n'], x[m, n]) x[m + m', n + n']}{\sum_{[m', n'] \in \Omega} h(x[m + m', n + n'], x[m, n])}$$

Adaptive Fuzzy Filtering

■ СВОЙСТВА

$$\lim_{|x[m+m', n+n'] - x[m, n]| \rightarrow 0} h(x[m+m', n+n'], x[m, n]) = 1$$

$$\lim_{|x[m+m', n+n'] - x[m, n]| \rightarrow \infty} h(x[m+m', n+n'], x[m, n]) = 0$$

$$h(x[m+m'_1, n+n'_1], x[m, n]) \geq h(x[m+m'_2, n+n'_2], x[m, n])$$

$$\text{if } |x[m+m'_1, n+n'_1] - x[m, n]| \leq |x[m+m'_2, n+n'_2] - x[m, n]|$$

■ Пример

$$h(x[m+m', n+n'], x[m, n]) = \exp\left(-\frac{(x[m+m', n+n'] - x[m, n])^2}{2\sigma^2}\right)$$

Adaptive Fuzzy Filtering

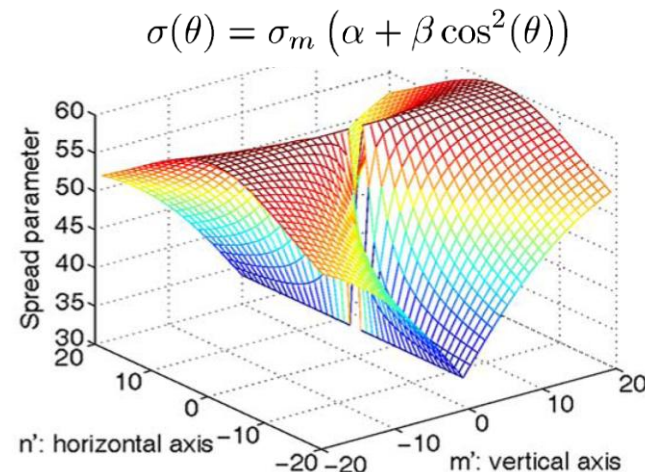
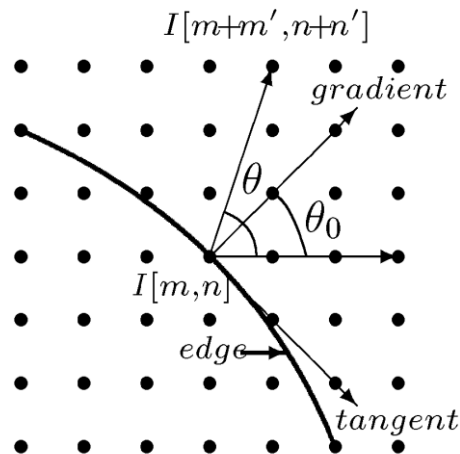
Геометрическая зависимость

$$\sigma(x[m+m', n+n'], x[m, n]) = K[m+m', n+n'] \times \sigma_m[m, n]$$

σ — вес

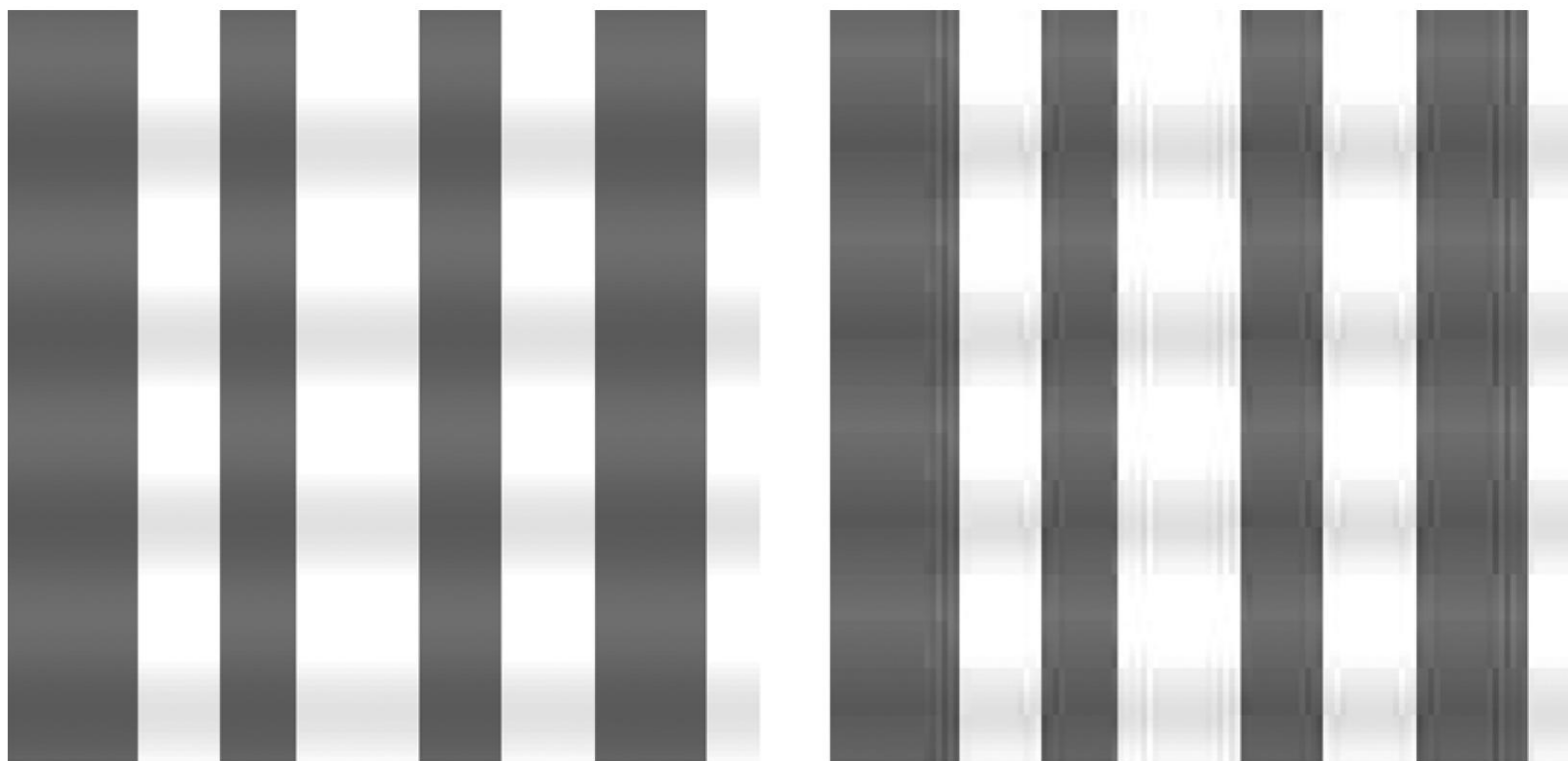
σ_m — зависимость от положения

K — зависимость от направления



Adaptive Fuzzy Filtering

Пример



исходное
изображение

сжатое
изображение

Adaptive fuzzy filtering for artifact reduction in compressed images and videos,
Dung T. Võ, Truong Q. Nguyen, Sehoon Yea, Anthony Vetro, IEEE Transactions
on Image Processing, Volume 18 , Issue 6 (June 2009), pp. 1166-1178

Adaptive Fuzzy Filtering

$$\sigma(x[m + m', n + n'], x[m, n]) = K[m + m', n + n'] \times \sigma_m[m, n]$$

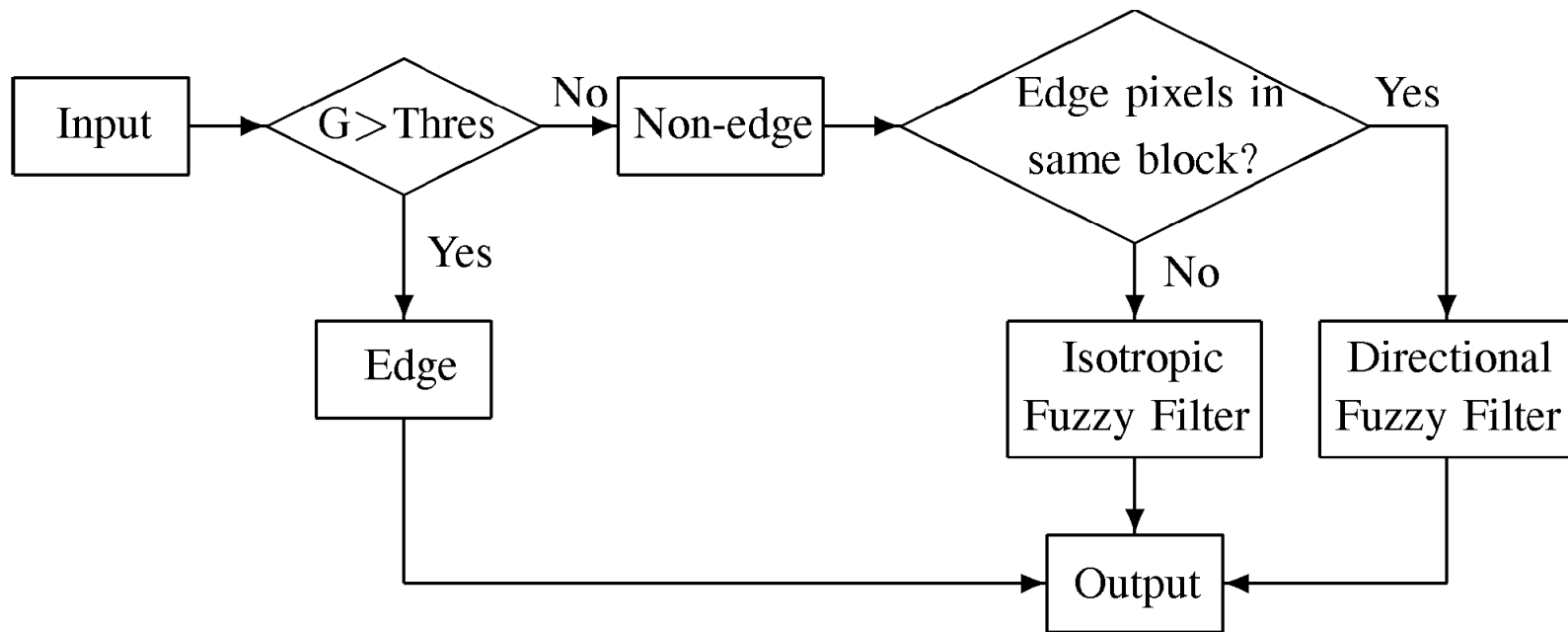
Зависимость от положения:

$$\sigma_m[m, n] = \sigma_0 \left((1 - \gamma) \left(\frac{STD(I[m, n]) - STD_{\min}}{STD_{\max} - STD_{\min}} \right) + \gamma \right)$$

STD – стандартное отклонение в окрестности

Adaptive Fuzzy Filtering

Directional Fuzzy Filter



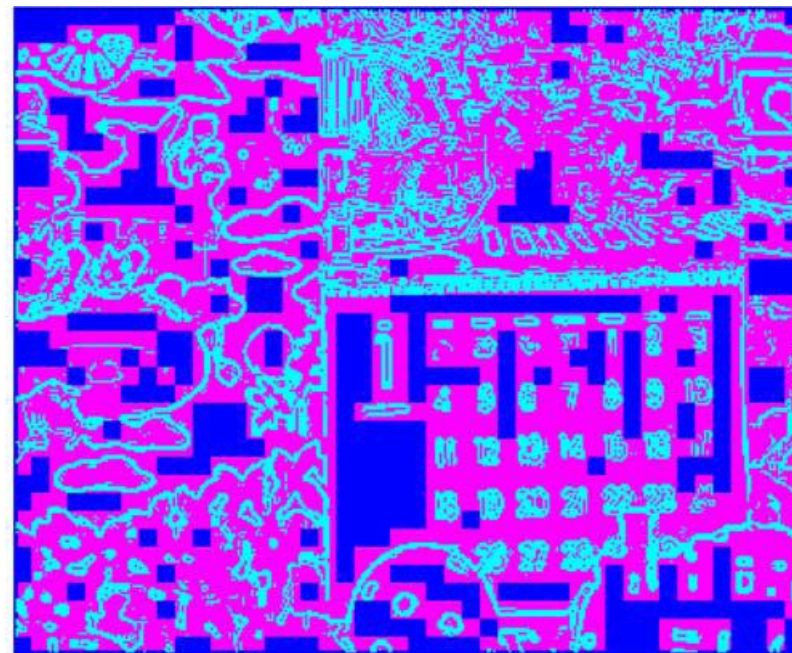
Directional Fuzzy Filter

Adaptive Fuzzy Filtering

Directional Fuzzy Filter

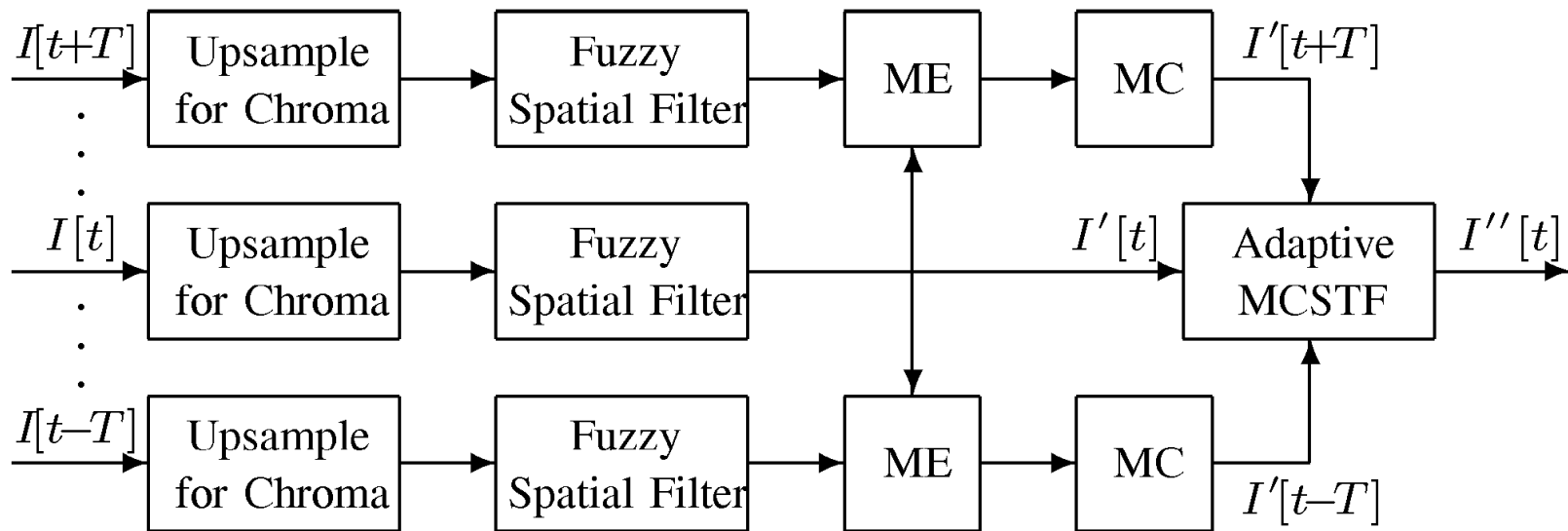


сжатое видео



классификация блоков

Adaptive Fuzzy Filtering Spatiotemporal Filter



Adaptive Fuzzy Filtering

Spatiotemporal Filter



$$I''[t, m, n] = \frac{\sum_{[t', m', n'] \in \Omega} h[t', m', n'] I'[t + t', m + m', n + n']}{\sum_{[t', m', n'] \in \Omega} h[t', m', n']}$$

$$h[t', m', n'] = \exp \left(- \frac{(I'[t + t', m + m', n + n'] - I'[t, m, n])^2}{2\sigma^2[t', m', n']} \right)$$

Adaptive Fuzzy Filtering

Spatiotemporal Filter



$$\sigma[t', m', n'] = K[t', m', n'] \times \sigma_m[m, n]$$

Корреляция $K[t', m', n'] = \frac{\sigma_{12}}{\sigma_1 \sigma_2}$

$$\sigma_{12} = \sum_{[m_0, n_0] \in V} I'[t + t', m + m' + m_0, n + n' + n_0] \\ \times I'[t, m + m_0, n + n_0]$$

$$\sigma_1 = \sqrt{\sum_{[m_0, n_0] \in V} I'[t + t', m + m' + m_0, n + n' + n_0]^2}$$

Adaptive Fuzzy Filtering

Результаты



PSNR:

Sequences	4Q	Chen	Liu	Conventional Fuzzy	Adaptive Fuzzy
News	27.48	27.58	27.55	27.94	28.05
Silent	27.84	28.37	28.33	28.33	28.58
Foreman	28.06	28.46	28.41	28.78	28.87
Mobile	21.22	20.96	21.13	21.50	21.55
Mother	31.02	31.83	31.62	31.77	32.00
Paris	23.38	23.25	23.31	23.80	23.84
Average gain		0.2433	0.2267	0.5200	0.6483

Adaptive Fuzzy Filtering

Результаты



Оригинал

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Adaptive Fuzzy Filtering

Результаты



Сжатое изображение

Adaptive fuzzy filtering for artifact reduction in compressed images and videos,
Dung T. Võ, Truong Q. Nguyen, Sehoon Yea, Anthony Vetro, IEEE Transactions 32
on Image Processing, Volume 18 , Issue 6 (June 2009), pp. 1166-1178

Adaptive Fuzzy Filtering

Результаты

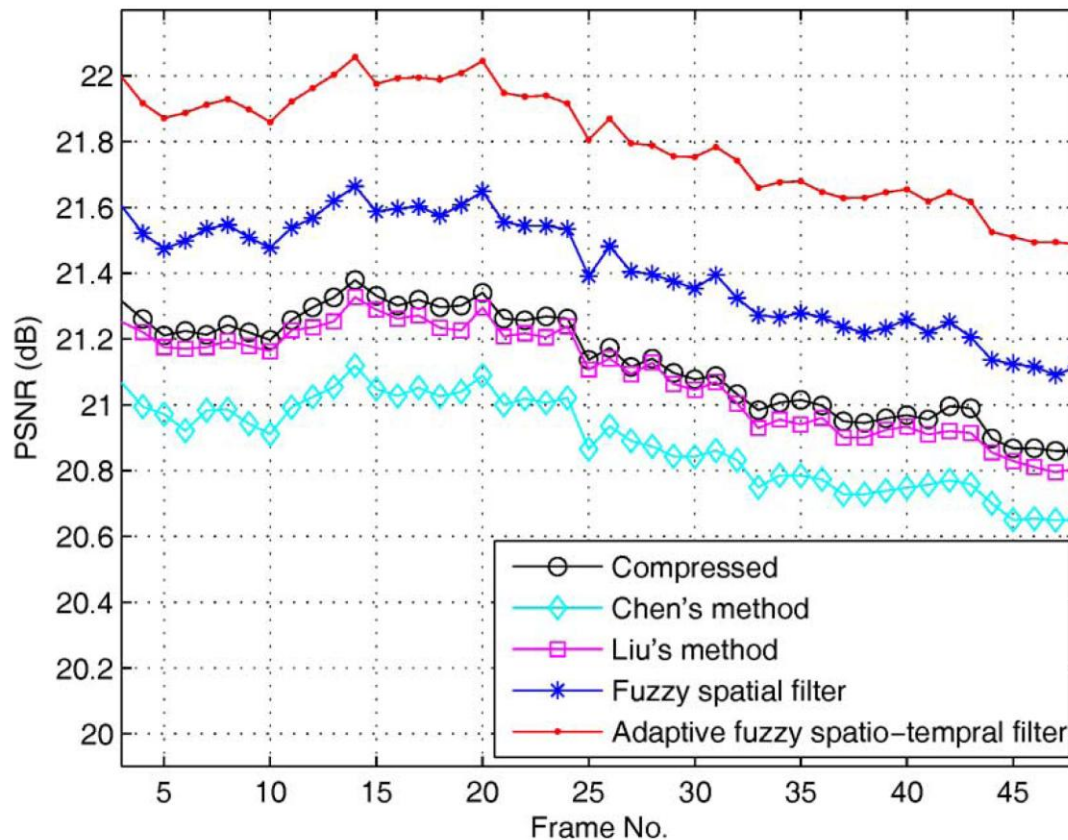


Восстановленное изображение

Adaptive fuzzy filtering for artifact reduction in compressed images and videos,
Dung T. Võ, Truong Q. Nguyen, Sehoon Yea, Anthony Vetro, IEEE Transactions 33
on Image Processing, Volume 18 , Issue 6 (June 2009), pp. 1166-1178

Adaptive Fuzzy Filtering

Результаты



Adaptive fuzzy filtering for artifact reduction in compressed images and videos, Dung T. Võ, Truong Q. Nguyen, Sehoon Yea, Anthony Vetro, IEEE Transactions on Image Processing, Volume 18, Issue 6 (June 2009), pp. 1166-1178

Adaptive Fuzzy Filtering

Результаты



Оригинал

Adaptive fuzzy filtering for artifact reduction in compressed images and videos,
Dung T. Võ, Truong Q. Nguyen, Sehoon Yea, Anthony Vetro, IEEE Transactions
on Image Processing, Volume 18 , Issue 6 (June 2009), pp. 1166-1178

Adaptive Fuzzy Filtering

Результаты



Сжатое изображение (30.77 dB)

Adaptive fuzzy filtering for artifact reduction in compressed images and videos,
Dung T. Võ, Truong Q. Nguyen, Sehoon Yea, Anthony Vetro, IEEE Transactions 36
on Image Processing, Volume 18 , Issue 6 (June 2009), pp. 1166-1178

Adaptive Fuzzy Filtering

Результаты



Восстановленное изображение — Fuzzy Spatial Filter(30.9 dB)

Adaptive fuzzy filtering for artifact reduction in compressed images and videos,
Dung T. Võ, Truong Q. Nguyen, Sehoon Yea, Anthony Vetro, IEEE Transactions 37
on Image Processing, Volume 18 , Issue 6 (June 2009), pp. 1166-1178

Adaptive Fuzzy Filtering

Результаты

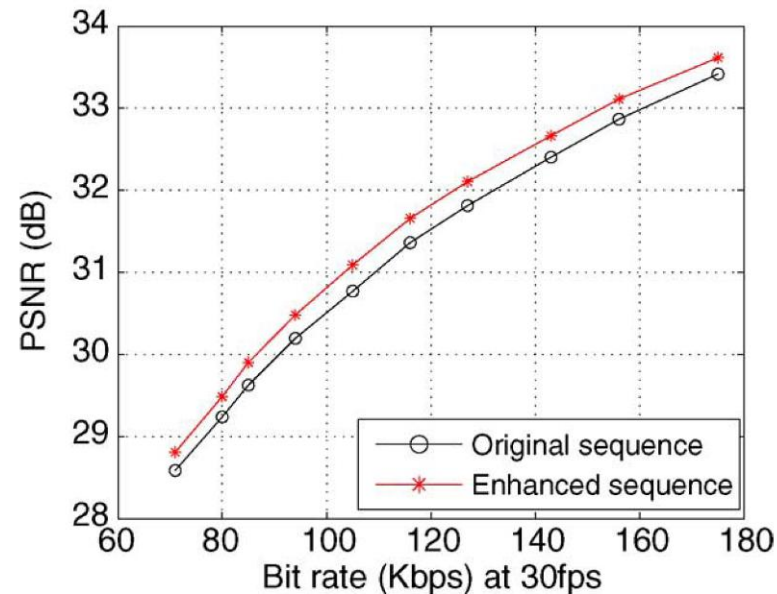
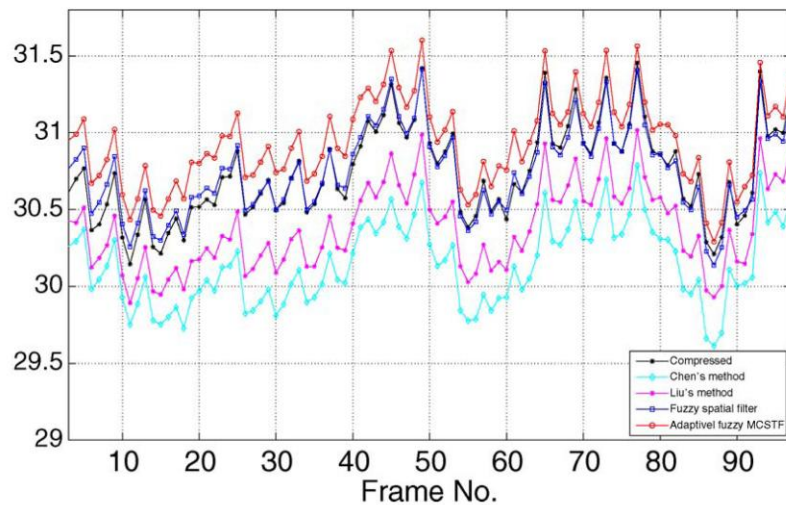


Восстановленное изображение — предложенный метод (31.09 dB)

Adaptive fuzzy filtering for artifact reduction in compressed images and videos,
Dung T. Võ, Truong Q. Nguyen, Sehoon Yea, Anthony Vetro, IEEE Transactions 38
on Image Processing, Volume 18 , Issue 6 (June 2009), pp. 1166-1178

Adaptive Fuzzy Filtering

Результаты





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Заключение

- Были рассмотрены два алгоритма
- Алгоритмы рассчитаны на высокую скорость работы



Литература

- **Adaptive fuzzy filtering for artifact reduction in compressed images and videos**, Dung T. Võ, Truong Q. Nguyen, Sehoon Yea, Anthony Vetro, IEEE Transactions on Image Processing, Volume 18 , Issue 6 (June 2009), pp. 1166-1178
- **Fast super-resolution reconstructions of mobile video using warped transforms and adaptive thresholding**, Sandeep Kanumuri, Onur G. Guleryuz, M. Reha Civanlar, SPIE Conf. on Applications of Digital Image Processing XXX, 2007



Вопросы

