LaBGen-P: A Pixel-Level Stationary Background Generation Method Based on LaBGen

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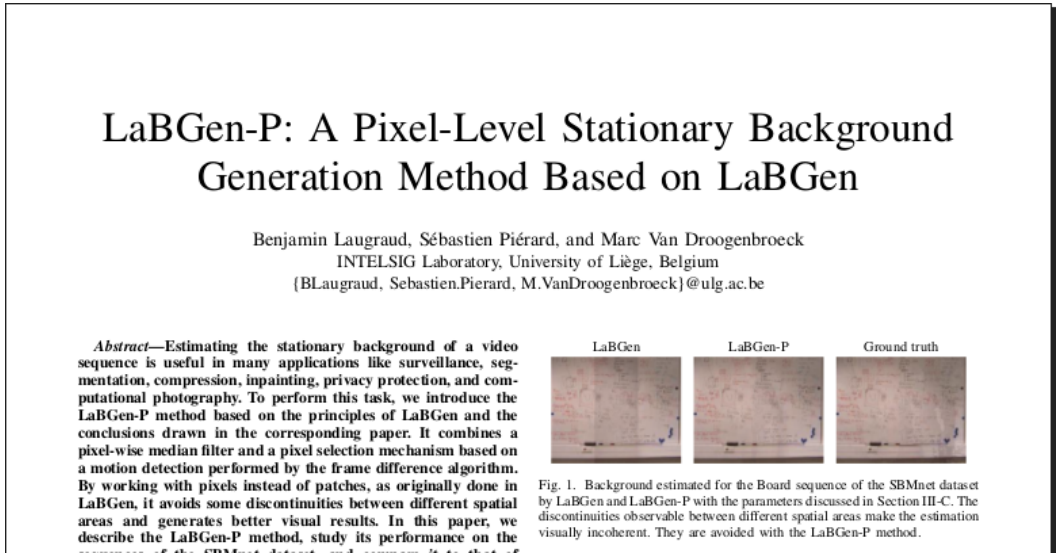
IEEE Scene Background Modeling Contest (SBMC 2016)

Cancun, Mexico

Introduction



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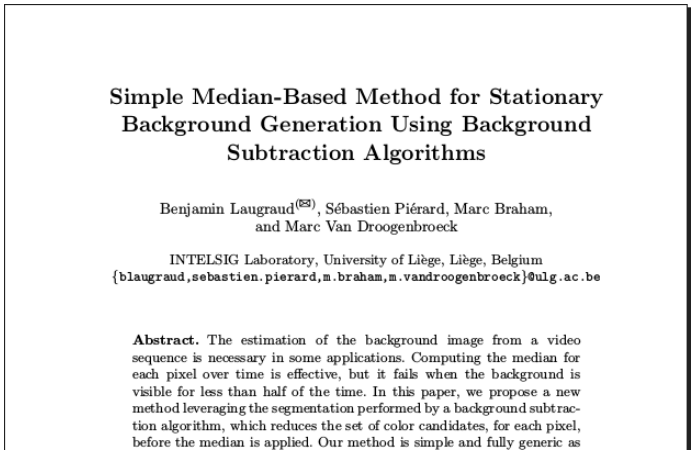
***Abstract*—Estimating the stationary background of a video sequence is useful in many applications like surveillance, segmentation, compression, inpainting, privacy protection, and computational photography. To perform this task, we introduce the LaBGen-P method based on the principles of LaBGen and the conclusions drawn in the corresponding paper. It combines a pixel-wise median filter and a pixel selection mechanism based on a motion detection performed by the frame difference algorithm. By working with pixels instead of patches, as originally done in LaBGen, it avoids some discontinuities between different spatial areas and generates better visual results. In this paper, we describe the LaBGen-P method, study its performance on the**

Fig. 1. Background estimated for the Board sequence of the SBMnet dataset by LaBGen and LaBGen-P with the parameters discussed in Section III-C. The discontinuities observable between different spatial areas make the estimation visually incoherent. They are avoided with the LaBGen-P method.

URL: http://hdl.handle.net/2268/201146

- LaBGen-P is a stationary background generation method.
- It is a simpler pixel-based version of LaBGen.
- LaBGen should be introduced to understand LaBGen-P.

LaBGen



Simple Median-Based Method for Stationary Background Generation Using Background Subtraction Algorithms

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Abstract. The estimation of the background image from a video sequence is necessary in some applications. Computing the median for each pixel over time is effective, but it fails when the background is visible for less than half of the time. In this paper, we propose a new method leveraging the segmentation performed by a background subtraction algorithm, which reduces the set of color candidates, for each pixel, before the median is applied. Our method is simple and fully generic as

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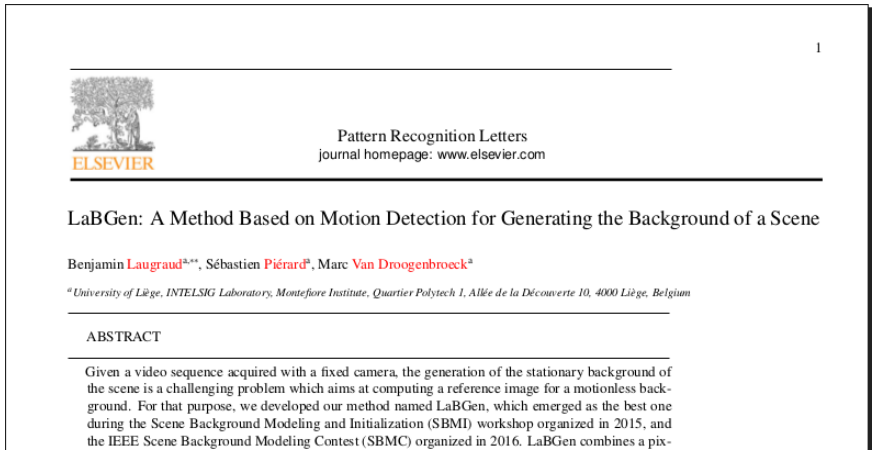

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LaBGen: A Method Based on Motion Detection for Generating the Background of a Scene

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ABSTRACT

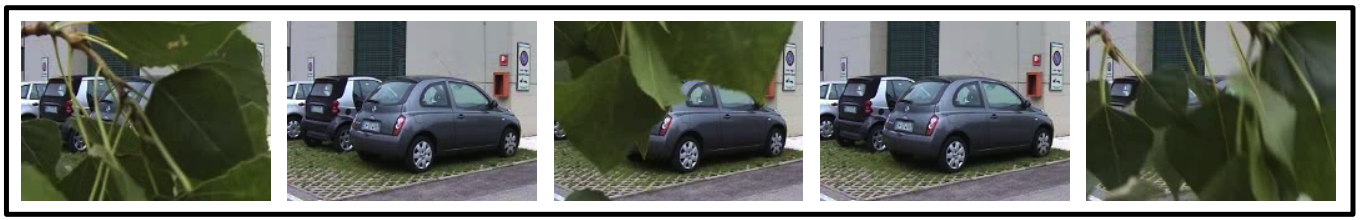
Given a video sequence acquired with a fixed camera, the generation of the stationary background of the scene is a challenging problem which aims at computing a reference image for a motionless background. For that purpose, we developed our method named LaBGen, which emerged as the best one during the Scene Background Modeling and Initialization (SBMI) workshop organized in 2015, and the IEEE Scene Background Modeling Contest (SBMC) organized in 2016. LaBGen combines a pix-

URL: http://hdl.handle.net/2268/203572

- It combines a pixel-wise median filter and a patch selection mechanism.
- The selection mechanism is based on motion detection.
- This mechanism selects the patches with the smallest amounts of motion.
- The pipeline of the method comprises 5 steps.

LaBGen: Step 1 - Augmentation

- Increases the duration of the input video sequence.
- In fact, we process the sequence in $\mathcal{P}$ passes.
- An odd pass is performed forwards while an even pass is performed backwards.

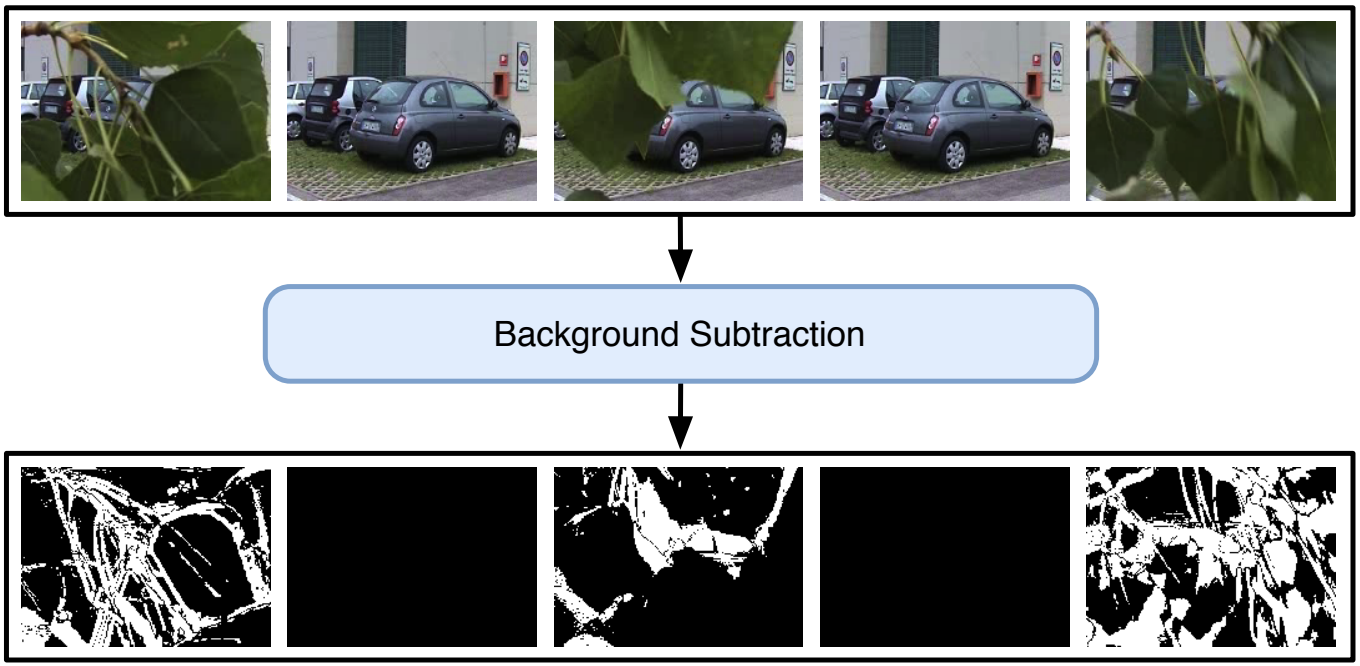


forwards (odd passes)

backwards (even passes)

LaBGen: Step 2 - Motion detection

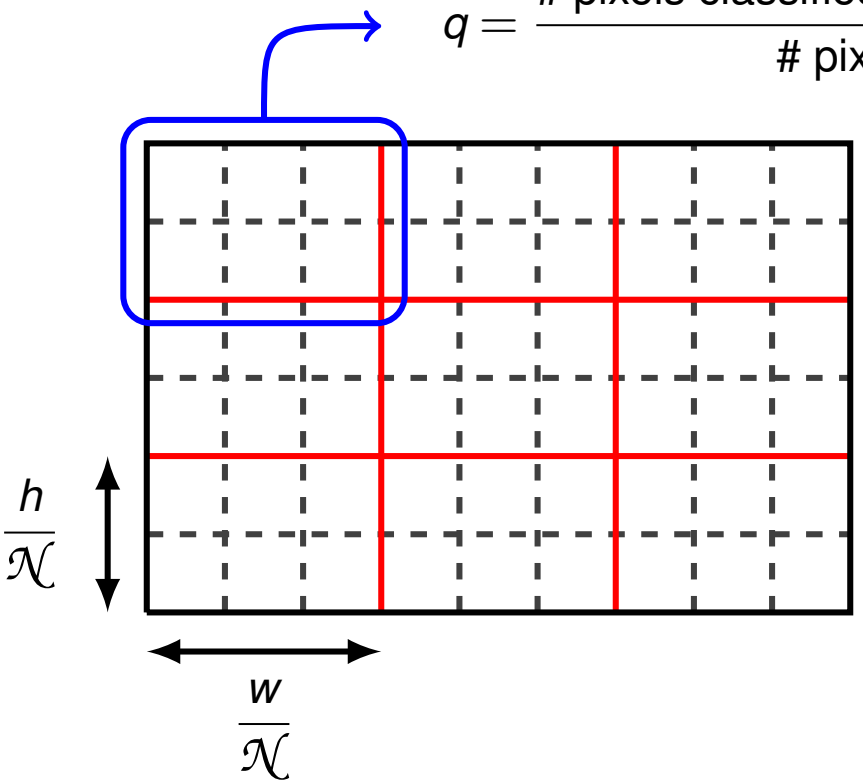
- We chose to work with background subtraction (bgs) algorithms.
- The training of the considered algorithm $\mathcal{A}$ is helped by the augmentation step.
- LaBGen does not use the model of $\mathcal{A}$, only segmentation maps.
- LaBGen can be used with any bgs algorithm “out-of-the-box”.



LaBGen: Step 3 - Local estimation of the quantity of motion

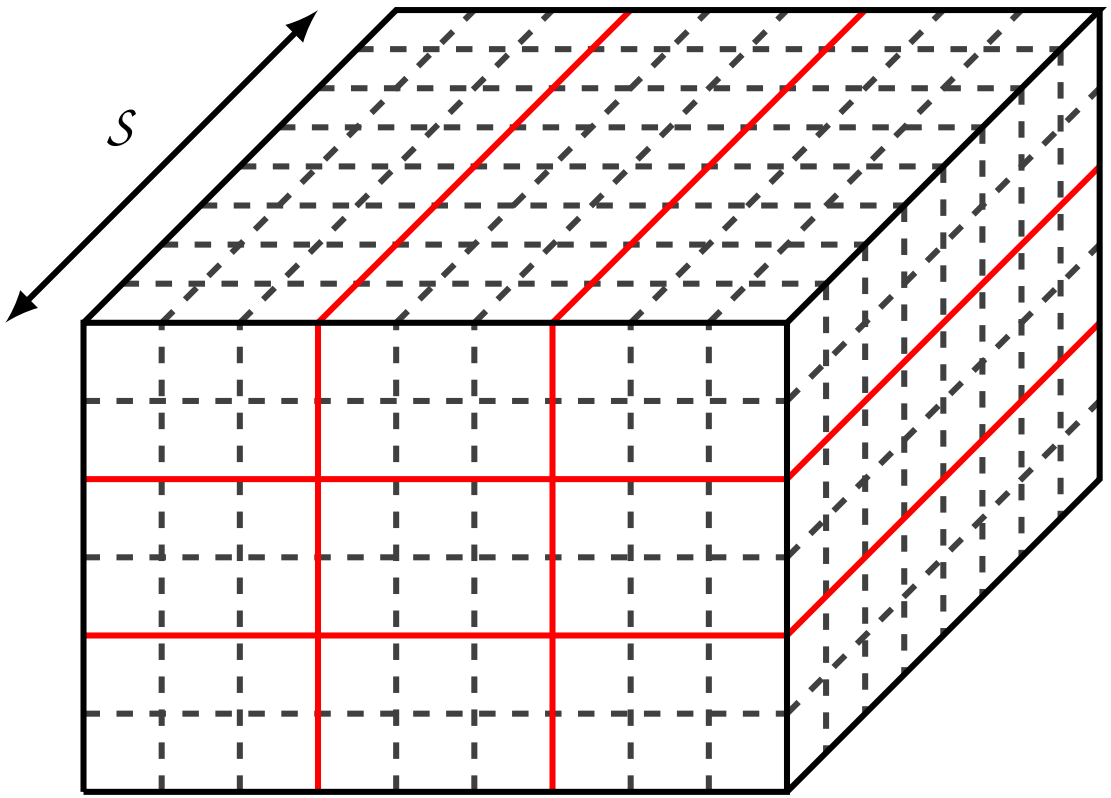
- The image plane is divided into $\mathcal{N} \times \mathcal{N}$ spatial areas.
- A quantity of motion q is estimated for each patch.
- It represents the probability of observing pixels corresponding to moving objects.

$$q = \frac{\text{\# pixels classified as foreground in the patch}}{\text{\# pixels in the patch}}$$



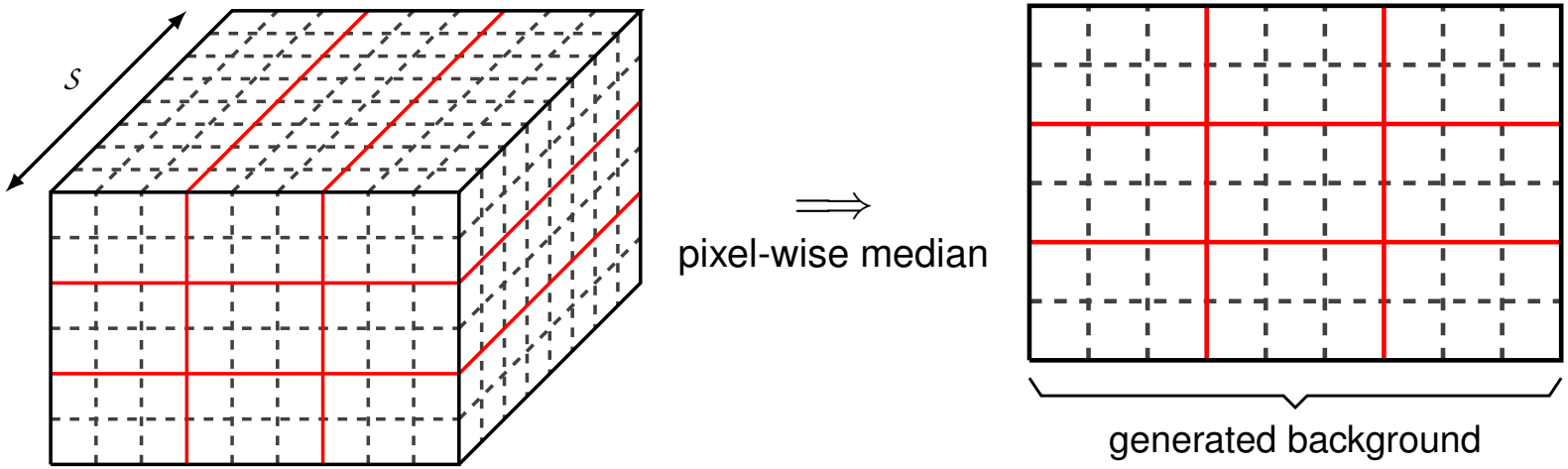
LaBGen: Step 4 - Patch selection

- In each spatial area, $\mathcal{S}$ patches are selected.
- The $\mathcal{S}$ selected patches are associated to the smallest quantities of motion q.



LaBGen: Step 5 - Background generation

- A pixel-wise median filter is applied on the sets of $\mathcal{S}$ selected patches.
- The background is then generated.



LaBGen-P: Motivation

- Sometimes, with LaBGen, we have a "patch effect".
- We wanted to make a pixel-based method to avoid this effect.
- LaBGen-P(ixel).

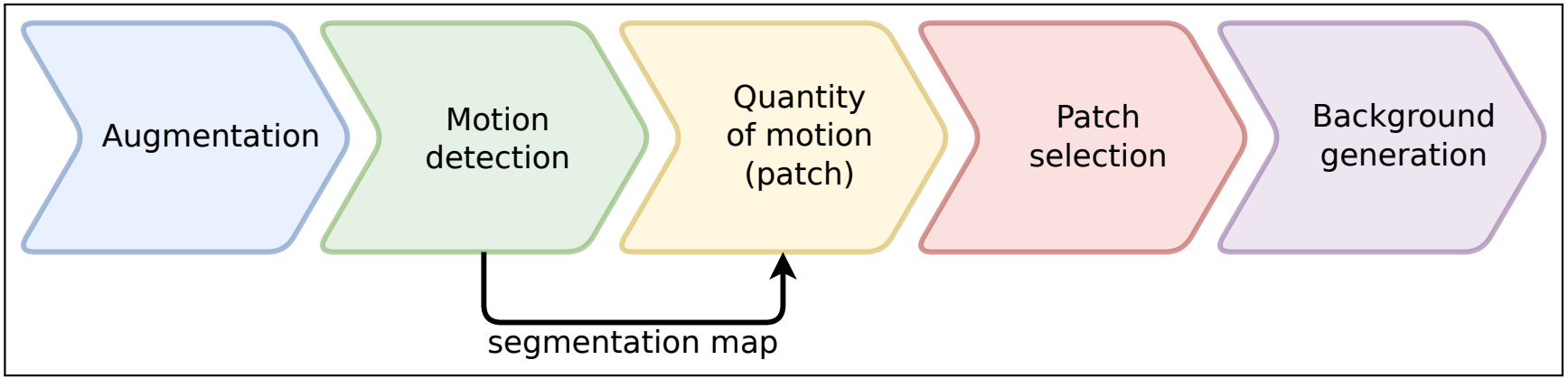
LaBGen

LaBGen-P

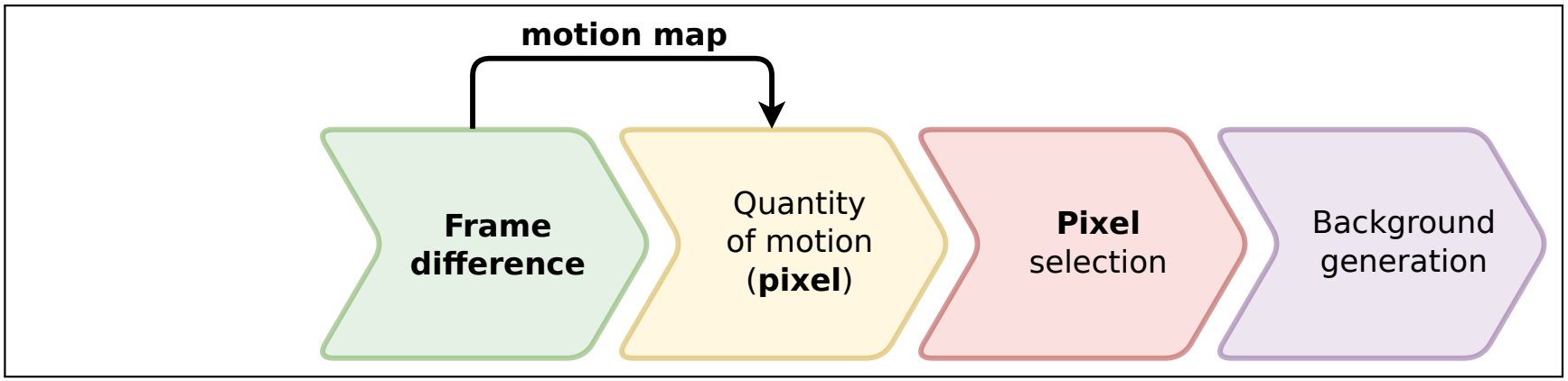
Ground truth

Backgrounds estimated with the same parameters!

LaBGen-P: What is new?



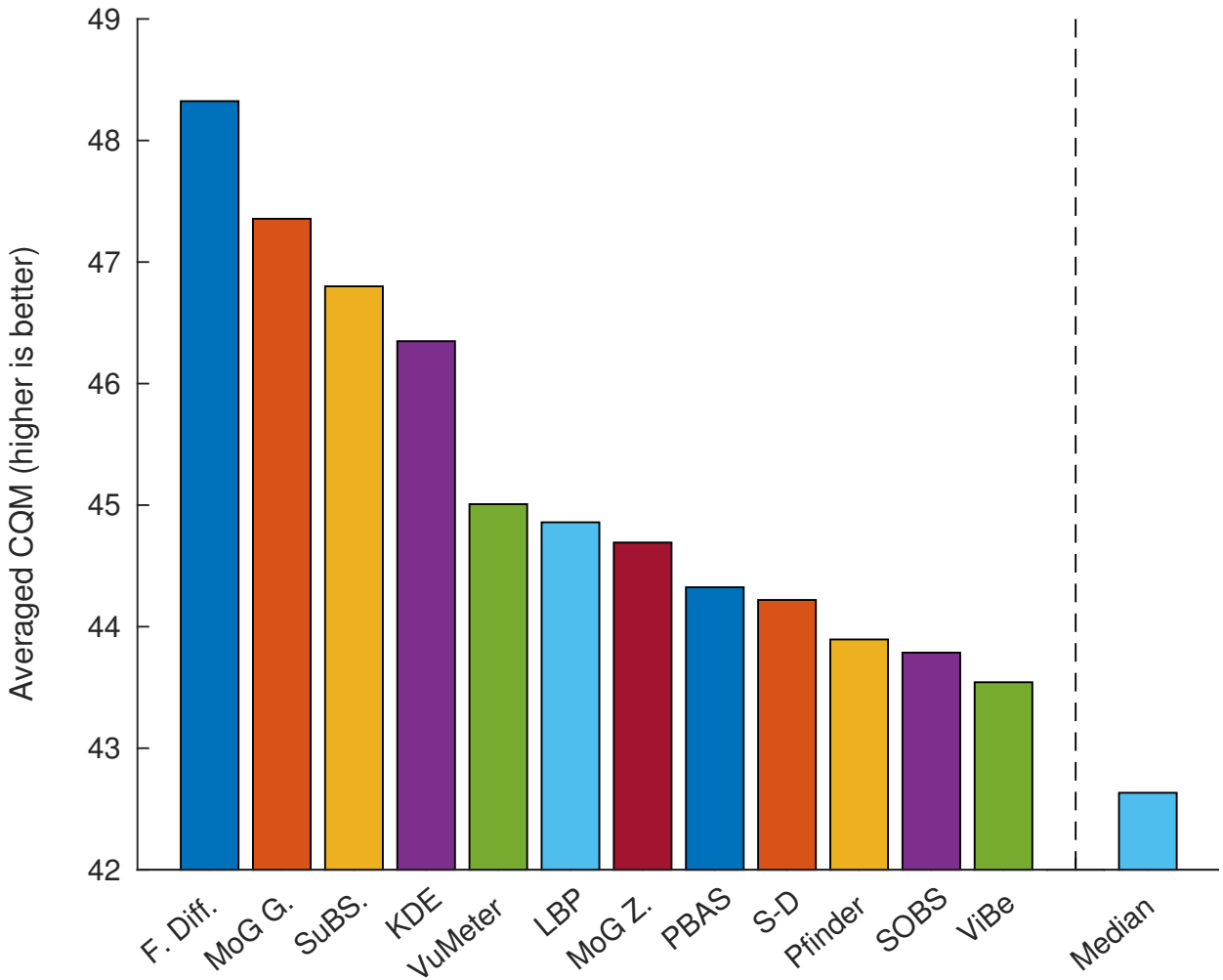
LaBGen ⇑ ⇓ LaBGen-P



LaBGen-P is now pixel-based!

LaBGen-P: Frame difference

- The frame difference has the most valuable contribution in average for LaBGen.
- Only the frame difference is used in LaBGen-P (no $\mathcal{A}$ and $\mathcal{P}$ parameter).



LaBGen-P: Motion maps

- No threshold is applied on the resulting differences (*motion scores*) any more.
- The motions scores are put in a *motion map*.
- Such a map allows to capture some shades about motion.
- For instance: $200 > 20 \rightarrow fg$, $30 > 20 \rightarrow fg$, but $p(fg|200) > p(fg|30)$.

Motion map

Segmentation map ($\tau = 20$)

LaBGen-P: Local estimation of the quantity of motion

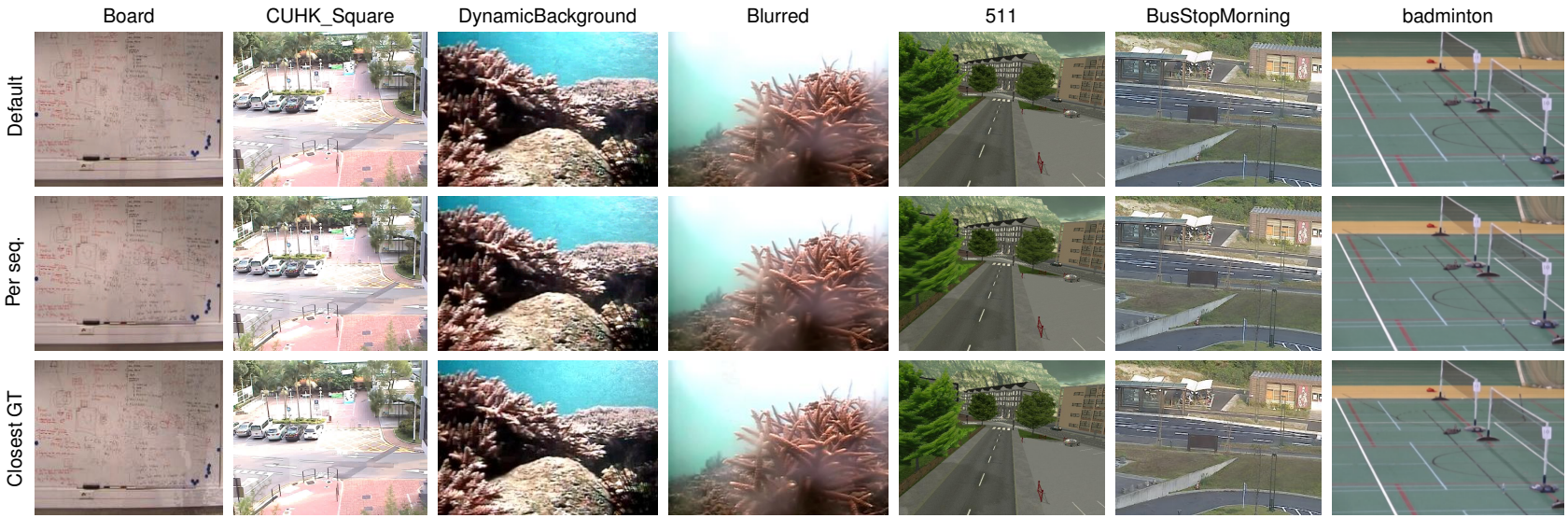
- Unlike in LaBGen, quantities of motion are estimated per pixel, but locally!
- The motion scores available in the local neighbourhood are aggregated (sum).
- The local neighbourhood is delimited by a window centered on the current pixel.
- The size of the window depends on the parameter $\mathcal{N}$.

85	22	5	71	50	86	39	3
59	11	82	87	51	26	57	2
60	53	84	31	17	35	63	25
91	36	56	14	61	66	65	13
7	42	24	99	77	38	45	30
75	92	1	9	20	4	19	96
48	83	18	73	74	29	98	88
33	47	23	94	52	68	97	8

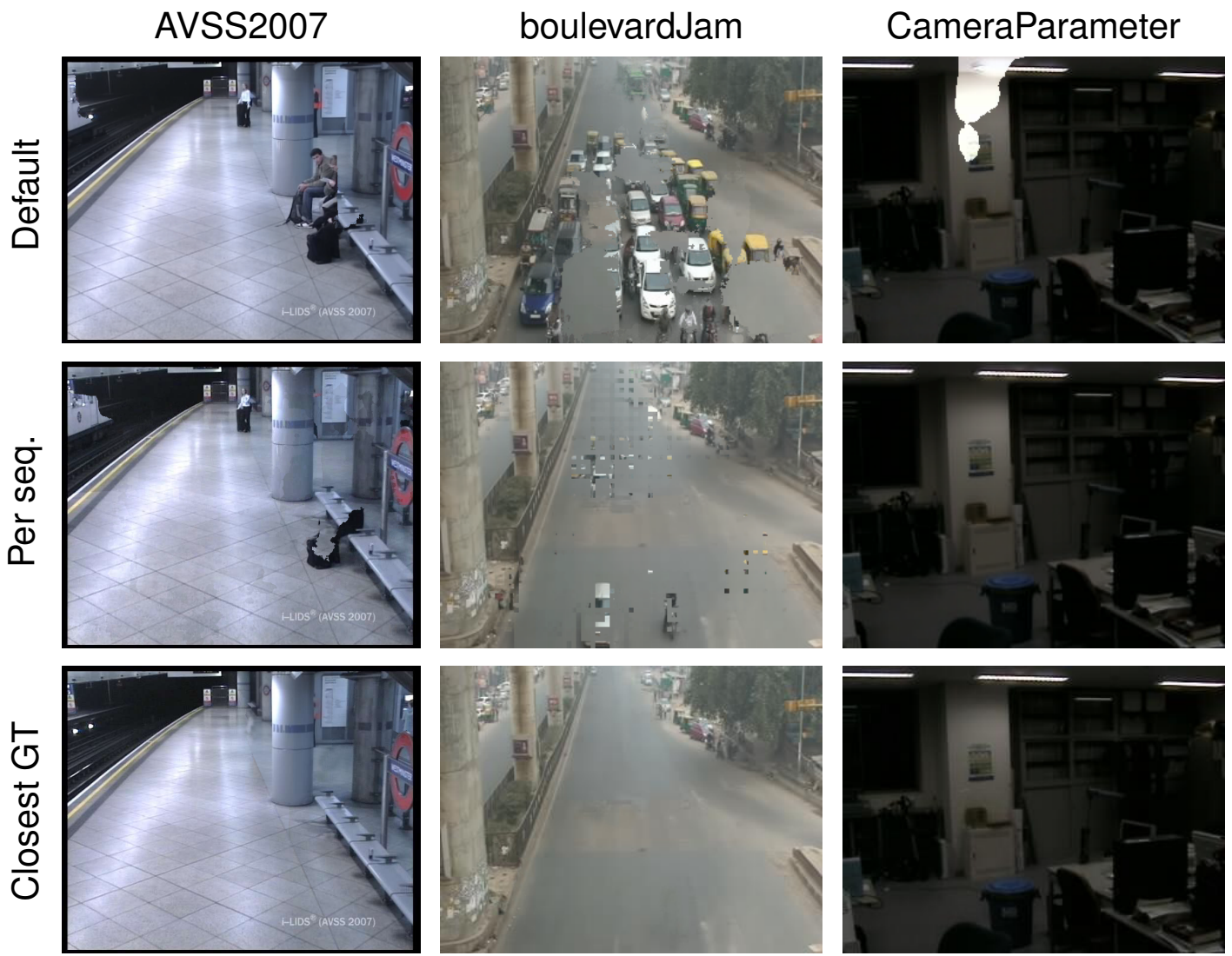
Motion map (5×5 window)

quantity of motion of $\square = \sum_{\square} = 1120$

Visual results



Drawbacks


AVSS2007
boulevardJam
CameraParameter
Default
Per seq.
Closest GT

Quantitative evaluation

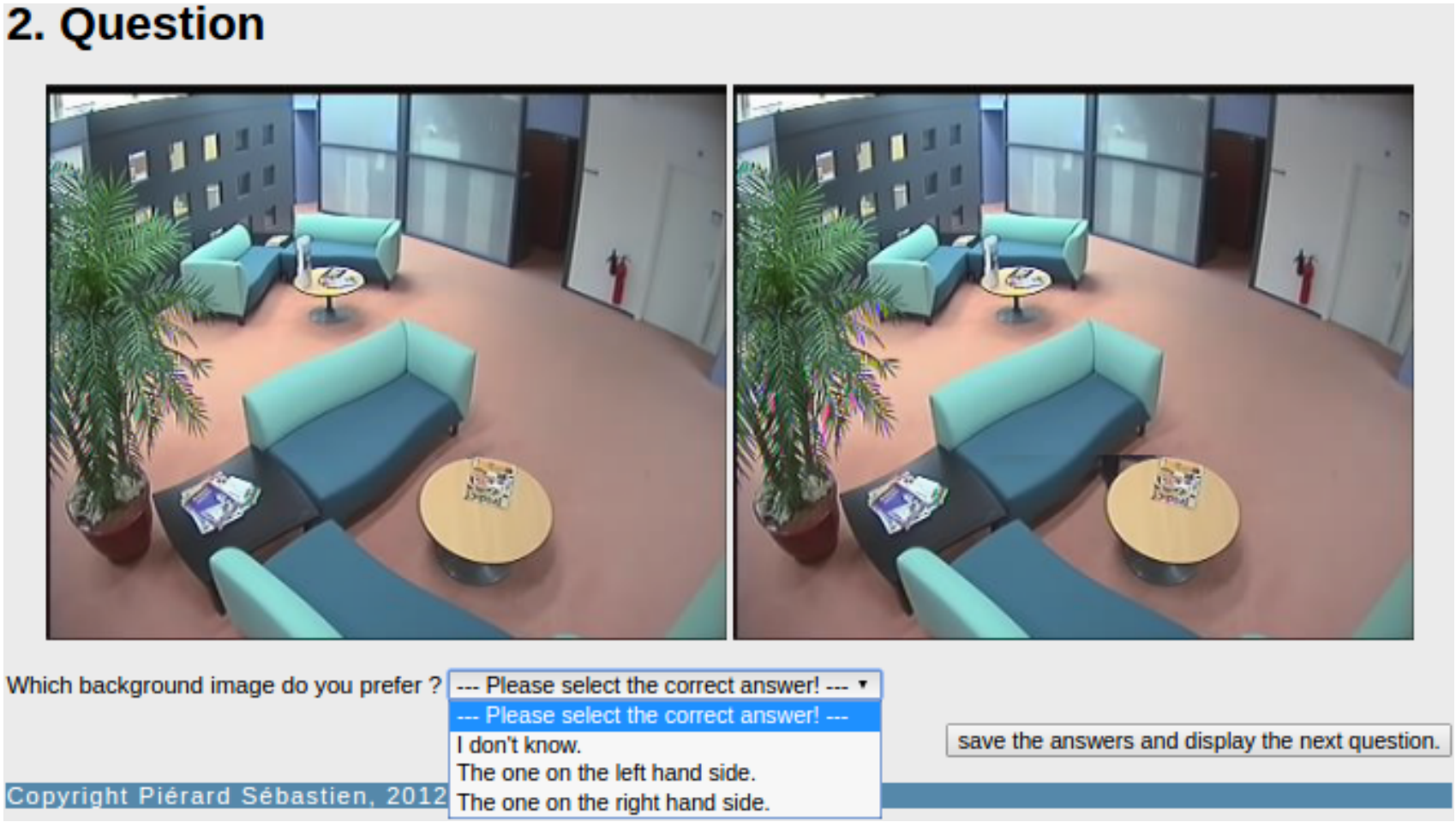
- We have ground-truth (GT) for $\simeq 1/6$ of the sequences.
- Metrics consider LaBGen-P better for half of the sequences with GT.
- Is LaBGen-P better than LaBGen considering the overall dataset?

Subjective evaluation - Web platform

1. Video for which we would like to define a background image

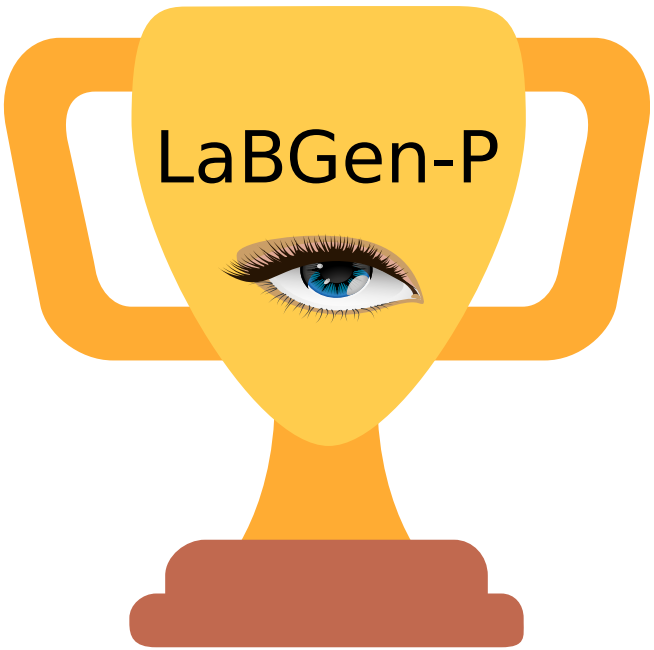
video/Candela_m1.10.m4v

Subjective evaluation - Web platform



Subjective evaluation

- **35** human experts participated.
- We collected **2210** answers ($\simeq$ **28** answers in average per video sequence).
- Unable to choose between LaBGen and LaBGen-P for **38** sequences.
- LaBGen-P was prefered for **26** sequences and LaBGen for **15** sequences.



SBMnet benchmarking platform (SBMC 2016) ☺️

Results (September 12, 2016)

Overall | Basic | Intermittent Motion | Clutter | Jitter | Illumination Changes | Background Motion | Very Long | Very Short

Results, all categories combined.

Click on method name for more details.

Method	Average ranking	Average ranking across categories	Average AGE	Average pEPs	Average pCEPs	Average MS-SSIM	Average PSNR	Average CQM
LaBGen [6]	2.00	4.75	6.7090	0.0631	0.0265	0.9266	28.6396	29.4668
LaBGen-P [7]	2.83	5.38	7.0738	0.0706	0.0319	0.9278	28.4660	29.3196
Photomontage [3]	3.33	6.50	7.1950	0.0686	0.0257	0.9189	28.0113	28.8719
SC-SOBS-C4 [9]	4.33	6.00	7.5183	0.0711	0.0242	0.9160	27.6533	28.5601
MAGRPCA [10]	5.83	6.88	8.3132	0.0994	0.0567	0.9401	28.4556	29.3152
Temporal median filter [2]	7.17	5.50	8.2761	0.0984	0.0546	0.9130	27.5364	28.4434
BE-AAPSA [14]	7.17	7.88	7.9086	0.0873	0.0447	0.9127	27.0714	27.9811
Bidirectional Analysis [13]	7.67	6.63	8.3449	0.0756	0.0181	0.9085	26.1722	27.1637
Bidirectional Analysis and Consensus Voting [12]	8.67	7.75	8.5816	0.0724	0.0257	0.9078	26.1018	27.1000
TMFG [11]	10.00	6.25	7.4020	0.1051	0.0566	0.9043	27.1347	28.0530
FC-FlowNet [5]	10.17	9.00	9.1131	0.1128	0.0599	0.9162	26.9559	27.8767
RSL2011 [4]	11.17	10.25	9.0443	0.1008	0.0497	0.8891	25.8051	26.7986
AAPSA [1]	12.17	10.88	9.2044	0.1057	0.0523	0.9000	25.3947	26.3021
RMR [8]	12.50	10.00	9.5363	0.1176	0.0582	0.8790	26.5217	27.4549

SBMnet benchmarking platform (November 19th 2016) 😔

Results for SBMnet 2016

Overall | Basic | Intermittent Motion | Clutter | Jitter | Illumination Changes | Background Motion | Very Long | Very Short

Results, all categories combined.

Click on method name for more details.

Method	Average ranking	Average ranking across categories	Average AGE	Average pEPs	Average pCEPS	Average MSSSIM	Average PSNR	CQM
MSCL [15]	1.00	4.13	5.9547	0.0524	0.0171	0.9410	30.8952	31.7049
BEWiS [24]	3.17	4.88	6.7094	0.0592	0.0266	0.9282	28.7728	29.6342
LaBGen [6]	3.67	6.38	6.7090	0.0631	0.0265	0.9266	28.6396	29.4668
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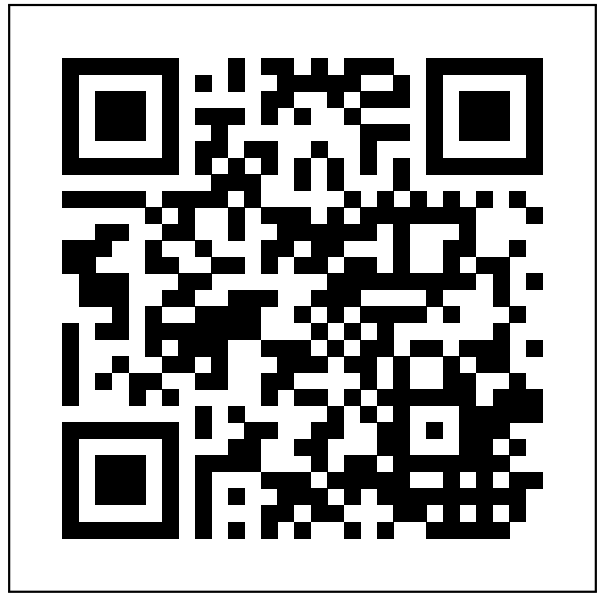
RMAMR [20]	13.50	13.63	9.6995	0.1243	0.0770	0.9258	26.5380	27.4680
RSL2011 [4]	13.83	15.38	9.0443	0.1008	0.0497	0.8891	25.8051	26.7986

Conclusion

- LaBGen-P is a variant of the LaBGen method.
- It combines a pixel-wise median filter and a pixel selection mechanism.
- It uses the frame difference as a motion detection algorithm.
- Quantities of motion are computed spatially by aggregating motion scores.
- It performs well on the SBMnet dataset.
- The metrics consider LaBGen-P less effective than LaBGen.
- A subjective evaluation has shown the contrary.
- Shall we find a metric even more correlated with the human eye?

Thank you for your attention!

Do you have questions?



LaBGen website