Nadia Abdullah
Universiti Putra Malaysia

How do we know what kind of noise (e.g. Gaussian, salt and pepper, etc) is present in an image?

Hi, everyone.

I will be processing a series of images obtained from calibration of Thermochromic Liquid Crystals. I use a digital video camera to record video of the experiment and then I use Adobe Premiere Pro software to convert the video into a sequence of image frames (file format: Bitmap).

I am going to implement a noise filter in my image-processing code, which is written in MATLAB. I have checked out the literature relating to TLCs and the most common filter used is a 5x5 median filter. As far as my knowledge goes, median filter is effective to remove salt and pepper noise.

However, I am aware that there are other types of image noise as well (e.g. Gaussian noise). I would like to ask:

1) How do we know what kind of noise is present in the images?

My concern is that if the noise present in the images is Gaussian rather than salt and pepper noise, then a median filter will not be that suitable.

I will greatly appreciate your feedback on this. Thanks.

TOPICS

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Jun 20, 2015

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POPULAR ANSWERS

Mehdi Farhangi · University of Louisville

Hi Nadia,
One simple and straightforward solution is to analyze the histogram of the output image. If your camera disturbs images by Gaussian noise, it is more likely that the histogram of the image looks similar to Gaussian probability distribution function. Of course, same statement stands for other distributions like salt and pepper, gamma, etc.
However, if SNR is not very low, a more efficient way is to take a picture with your digital camera from a simple scene like a completely white sheet and then analyze the output image. In this case, it is more likely that the histogram be dominated by the noise, and you can determine the type of noise by looking at the shape of the histogram.

Jun 20, 2015

ALL ANSWERS (16)

Aparna Murthy

Salt and pepper is a kind of noise you can see - in the granularity , other kind of noises are contributed from sources (depends on how good quality of image you want) .If you want a crisper /sharper image , you can use 2 or more filters to remove them you will end up getting blurred image . Example: you can filter using filter(s) and then sharpen .

Gaussian pdf is like normal so when you filter with this you try removing

the noise(s), again it depends how you choose to want the quality of the image.

Jun 20, 2015

Dileep Kumar Yadav · Jawaharlal Nehru University

Dear Nadia Abdullah,

I want to share some brief information regarding your question.

1. Gaussian Noise:

Gaussian noise in digital images arise during acquisition e.g. sensor noise caused by poor illumination and/or high temperature, and/or transmission e.g. electronic circuit noise.

A typical model of image noise is Gaussian, additive, independent at each pixel, and independent of the signal intensity, caused primarily by Johnson–Nyquist noise (thermal noise), including that which comes from the reset noise of capacitors ("kTC noise"). Amplifier noise is a major part of the "read noise" of an image sensor, that is, of the constant noise level in dark areas of the image. In color cameras where more amplification is used in the blue color channel than in the green or red channel, there can be more noise in the blue channel. At higher exposures, however, image sensor noise is dominated by shot noise, which is not Gaussian and not independent of signal intensity.

Gaussian filtering is highly effective in removing Gaussian noise from the image.

The resulting effect is that Gaussian filters tend to blur edges, which is undesirable.

2. Salt and Paper Noise:

Fat-tail distributed or "impulsive" noise is sometimes called salt-and-pepper noise or spike noise. An image containing salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions. This type of noise can be caused by analog-to-digital converter errors, bit errors in transmission, etc. It can be mostly eliminated by using dark frame subtraction and interpolating around dark/bright pixels.

Dead pixels in an LCD monitor produce a similar, but non-random, display.

Median Filtering is highly effective in removing salt-and-pepper noise.

3. Apart from these many more filters are available.

4. You can use concept of convolution and low-pass-filter and high-pass-filter as a Low pass filters helps in removing noise, or blurring the image. A High Pass Filters filters helps in finding edges in an image.

For more detail: You can go through these links:

https://en.wikipedia.org/wiki/Image_noise

http://opencv-python-tutroals.readthedocs.org/en/latest/py_tutorials/py_imgproc/py_filtering/py_filtering.html

http://homepages.inf.ed.ac.uk/rbf/HIPR2/noise.htm

http://users.utcluj.ro/~rdanescu/PI-L10e.pdf

Jun 20, 2015

Mehdi Farhangi · University of Louisville

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Jun 20, 2015

Bipul Mohanto · LuxScan Technologies SarL

So simple, do Histogram analysis and categorize the histogram in the category of noise.

Jun 21, 2015

Peter van Beek · Sharp Laboratories of America

Hi Nadia,

If you are recording your video with a digital video camera, it will very likely be compressed and coded in one of the video coding standards (MPEG, H.264, etc). This means the video frames would also contain compression artifacts (coding noise). Some examples are blocking and ringing. Depending on the quality of the camera, coding standard, bit rate and complexity of the scene (amount of motion), there may be little coding noise or a lot. Best to select the highest bit rate and highest quality setting on your camera to minimize compression noise.

To further avoid camera noise (and increase SNR), you may want to provide good lighting conditions, if possible in your setup.

You may be in a position to minimize the amount of noise that is being captured in the frames. Always better to reduce noise in the first place, than trying to get rid of it afterwards.

You may want to take a close look at a few test images (frames) to get a sense for what type of noise they contain.

Best,

Peter

Jun 22, 2015

Pablo Negri · Argentine University of Business (UADE)

Dear Nadia Abdullah,

You can take a look to chaper 5 of the book "Digital Image Processing" from Gonzalez & Woods. They make a good analysis of noise models and propose some algorithms to reduce the Gaussian noise.

Regards,

Pablo

Jun 22, 2015

Nadia Abdullah · Universiti Putra Malaysia

Hi, everyone. Thanks for the feedback. I appreciate it. :)

Thanks a lot for the helpful tip, Peter. Yes, my video is recorded in the H.264 coding standard. I agree that it is best to minimize noise in the first place, rather than getting rid of it later. Given budget constraints, I am using a Sony PJ380 personal camcorder to record the video during experimental runs. Since my test plate is stationary throughout the experiments, motion will not be an issue. My test plate is also illuminated by two 18W full-spectrum light sources. I will follow your advice and get some test images first. Thanks again.

Jun 23, 2015

Vladimir Vasilyevich Lukin · KhAI - Aerospace university

Dear Nadia Abdullah, people above have already given to You several good advices. According to my experience, several actions can be

helpful. 1) You should analyze do You really have impulsive noise or not. For this purpose, You can look for models that describe Your type of images (video). Besides, You have to look at histograms of images and image fragments (selected manually) that seem homogeneous. Besides, You can carry out visual inspection of frames (images). Impulsive noise, especially, salt and pepper noise, is well seen. If it is really present, then You have to think how to remove it. But keep in mind that median filter is obviously not the best choice. Nowadays, a standard way is to detect impulsive pixels first and then to remove outliers in them without changing values in other pixels. After this, other types of noise (additive, signal-dependent) can be removed. 2) If impulsive noise is absent, this does not mean that You have just additive white Gaussian noise in Your images (frames). There are different types of noise that can be present and, in general, noise can be signal-dependent. 3) Any compression changes noise statistics and there is a limited number of papers that analyze such changes (I have such a paper at LNLA 2009, if needed, I can pass it). Meanwhile, after compression it becomes more difficult to remove noise than before compression.

Jun 23, 2015

Sabari Nathan · Cognizant Technology Solutions,chennai,India

Hi Nadia Abdullah,

Below i have mentioned the paper link. They have used neural network for classifiying the noise in the image. It gives better accuracy.

https://www.researchgate.net/publication/271457800_Automatic_noise_identification_in_images_using_moments_and_neural_network

Conference Paper: Automatic noise identification in images using moments and neural network

P. Vasuki · C. Bhavana · S. Mohamed Mansoor Roomi · E. Lakshmi Deebikaa

[Show abstract]

No preview · Conference Paper · Dec 2012

Jun 25, 2015

Vladimir Vasilyevich Lukin · KhAI - Aerospace university

dear all,

in fact, there are many papers dealing with blind identification of noise/distortion type in images (see https://scholar.google.com.ua/scholar?cites=11727429738195676 08&as_sdt=2005&sciodt=0,5&hl=ru and the citations to this paper).

However, the existing methods provide identification of a limited number of noise/distortions and there can be errors.

Jun 25, 2015

Lambert Zijp · Netherlands Cancer Institute

I agree with Vladimir, except when he says that the other advises were good!!

Take a 'seemingly' homogeneous part of the image, and analyze the histogram of only that part. A histogram of the whole image is worthless. If there are no homogeneous parts in the images, try making some other images and assume that the characteristics of the camera did not change...

Also keep in mind what Peter said about compression artefacts.

Jun 25, 2015

James Coggins · ViaSat, Inc.

The kind of noise present in images depends on the physics of the

lighting source, the path the light travels, and the acquisition channel. Basically, in order to understand noise, you have to understand the imaging process. I once had a biomedical project in which we took a dark field image to capture electronic noise and miscalibration and a light field image to catch sensor "hot spots" (areas where the sensor was more sensitive so measured intensities were higher). We then acquired 8 images in a row and averaged them, subtracted the dark field and divided by the light field. Then there was a deblurring stage but I think I covered the part of interest to you. In that project, the signal was known to be Poisson and there was a bleaching effect so the magnitude of the signal decreased as the illumination time increased. In some application areas, one person's noise is another person's data, so it is a good idea to check what other people analyzing similar images for different things are doing to control their noise (i.e. to isolate your DATA and eliminate it from their studies). Sounds like fun. Good luck.

Jun 26, 2015

Zdenek Svindrych · University of Virginia

I'm afraid that after lossy compression there is little to improve in your images. Moreover, the camcoder already tries it's best to fix faulty pixels, manage noise etc.

For real scientific work you need as little black-box processing as possible (no denoising, sharpening and the like). Then you can go into details studying the noise in your images, e.g. using 'photon transfer curve'
approach: http://www.couriertronics.com/docs/notes/cameras_application_notes/Photon_Transfer_Curve_Charactrization_Method.pdf

If you're lucky enough and your camcoder provides clean (uncompressed) live HDMI output, you can at leas get rid of compression artifacts using high-end HDMI recorder (there should also be some PC cards available on the market).

And are you sure you need 1080p60? With lower resolution or frame rate you can use still cameras that support RAW file format, or some Canon EOS with MagicLantern hack can record RAW video...

Good luck!

Jul 2, 2015

Nadia Abdullah · Universiti Putra Malaysia

Hi, Lambert, James and Zdenek.

Thank you all for great ideas. I will go through them before I make my next move. And I need all the 'luck' I can get. Hehehe.

Thanks again. :)

Jul 14, 2015

Sumit Kushwaha · Kamla Nehru Institute of Technology, Sultanpur

yes histogram of a noisy image show the noise pattern.

Jan 16, 2016

Nadia Abdullah · Universiti Putra Malaysia

Thank you for your feedback, Sumit. :)

Jan 19, 2016

Can you help by adding an answer?

Enter your answer

Add your answer