DETERMINATION AND SUPPRESSION OF NOISE FROM POWER SUPPLY CIRCUITS IN DIGITAL CAMERAS

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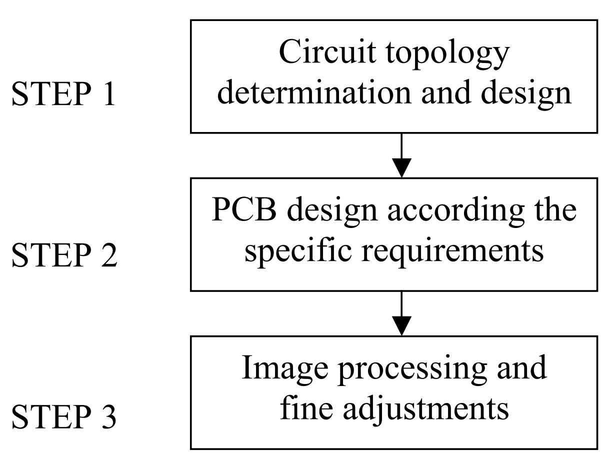
The paper describes the algorithm developed and used by the team to design and adjust the power supply circuit used in high quality digital camera system.

Keywords: switching power supply, low noise, digital camera, image processing, PCB design, circuit design

1. INTRODUCTION

The good power supply design is the key stone for successive project. Now a days it is very important to use high efficiency power supplies (over 85 – 90 % efficiency) according to the requirements of the contemporary "green" standards. The only way is to use switching power regulators, which is precondition for noise injection from power lines into sensitive analog parts like image sensor and ADC. The noise from power lines is very significant and can destroy the image quality especially when the images are made in dark environment with long exposure. Then the noise level is commensurable with useful signal. Algorithm developed and used by the team to design and adjust the power supply circuit used in high quality digital camera system. The methodology includes three main steps:

- circuit topology design and switching regulator chip selection
- PCB design and initial adjustments
- Fine adjustments including the use of image processing



The power supply used in the system is based on one chip switching regulator, selected after very deep research and additional tests in our laboratory of some chips. The development of low noise power supply is the first big step on the road to the achievement of really professional, low noise and with great performance digital camera irrespective of the other camera features – black and white camera or color camera, using of CCD sensor or CMOS sensor, motion camera or still camera. In the same way the using of one chip solution gives us the advantage of small size of PCB, low cost and increased reliability, which is very important to adopt the system into real production and exploitation.

2. PROBLEM STATEMENT

The main problem which we had to decide is how to decrease the noises from different sources. For this purpose we had to find decision how to determine the noise source. Our method must give us possibility:

- To create small-size power supply.
- To use standard components
- To create loopback between image and power supply adjustment.

3. DECISION

The algorithm developed and used by the team to design and adjust the power supply circuit used in high quality digital camera system. The methodology includes three main steps:

- circuit topology design
- PCB design and initial adjustments
- Fine adjustments including the use of image processing

The power supply used in the system is based on one chip switching regulator, selected after very deep research and additional tests in our laboratory of some chips. Using of one chip solution give us the advantage of small size of PCB, low cost and increased reliability which is very important to adopt the system into production. PCB design must be made very careful keeping all requirements about low resistance copper pours, as short as possible signal lines and high current traces. The base of our decision consists of using image post processing software (IDL5.6) to find relation between image quality to noise sources. Images taken in absolutely dark environment contains only two significant components – dark current noise of sensor and noise injected from power supply. Post processing algorithm includes calculation of deviation of the full image. We can see level, frequency and almost all parameters of noise which help us to determine the source of noise and make decision how to eliminate or decrease it (change components value, additional filters or PCB nets replacement).

On the base of the spectral analysis we investigated the influence of different periodical signals. We made it in following way:

- To avoid the influence thermal current we make minimal exposure
- The result from previous point is that the output signal from sensor includes only the readout noise plus external influences. The most significant external noise is the one from power supply.

At Fig. 1 you can see some parallel line structures which spectrum is identical with switc

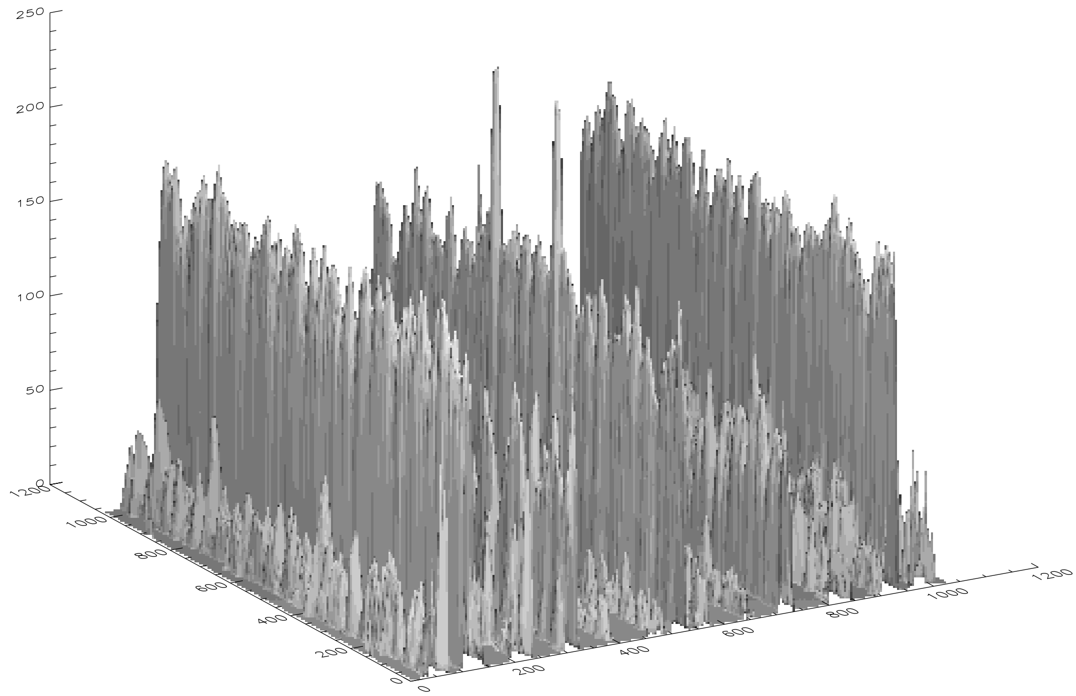


Fig.1.

After noise determination we had to measure its level. With IDL software we calculate the noise deviation in image and if its level is not good enough we adjust filter parameters in power supply.

$$\text{Mean} = \bar{x} = \frac{1}{N}\sum_{j=0}^{N-1} x_j$$

$$\text{Kurtosis} = \frac{1}{N}\sum_{j=0}^{N-1}\left(\frac{x_j-\bar{x}}{\sqrt{\text{Variance}}}\right)^4 - 3$$

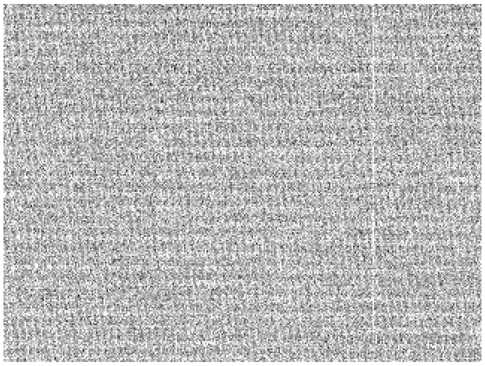
$$\text{Variance} = \frac{1}{N-1}\sum_{j=0}^{N-1}(x_j-\bar{x})^2$$

$$\text{Mean Absolute Deviation} = \frac{1}{N}\sum_{j=0}^{N-1}\left|x_j-\bar{x}\right|$$

$$\text{Standard Deviation} = \sqrt{\text{Variance}}$$

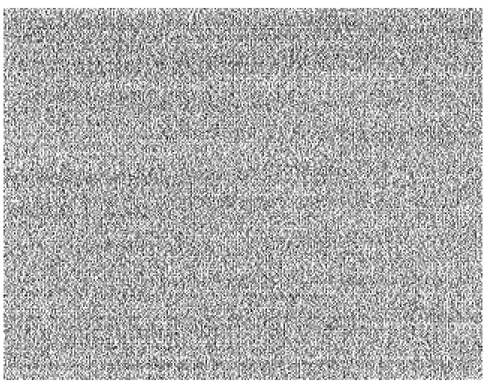
$$\text{Skewness} = \frac{1}{N}\sum_{j=0}^{N-1}\left(\frac{x_j-\bar{x}}{\sqrt{\text{Variance}}}\right)^3$$

At Fig. 2 and Fig. 3 we can see two images and their deviation values. The first is with higher values but the second one is with lower values after fine tuning in some parameters of filter values.



Basic Stats	Min	Max	**Stdev**
Band 1	0	37	**4.895758**

Fig.2



Basic Stats	Min	Max	**Stdev**
Band 1	0	34	**3.422293**

Fig.3

It is obviously higher noise levels in structure of Fig. 2 than structure of Fig. 3 which is with improved parameters of power supply circuit.

4. CONCLUSION

As seen from Fig.2 and Fig.3 our team succeeded to decide the problem which was defined as main task.- when the camera is adjusted to high intensity images and we want to get information from areas with small levels in signal intensity it is very important to minimize noise levels.

5. REFERENCES

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