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A Discussion on Parameters Effecting the Autofocussing Algorithms

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ABSTRACT: With the Rapid development of digital still camera technology autofocus has become an important function with a wide range of applications in the field of mobile devices, telescoping, and biomedical field. Autofocus is the modern technology in which maximum focus on the object is obtained through smartly adjusting the camera. Most important factors affecting the autofocus are the light intensity, contrast level and also depends on camera or object movement. In this paper we discuss on the different types of autofocussing method and most influencing parameter Point Spread Function (PSF)

KEYWORDS: Autofocussing, Passive, Active, Phase Detection, Contrast Detection, PSF

I. INTRODUCTION

The focus is critical when we shoot from a tripod we usually prefer manual focus. Manual focus is when the user controls focus of the lens manually using the focus ring. Thus the manual focus is slower process and at times it will miss the shots. The limitations in the manual focus can be overcome by using autofocussing method. Autofocus is a focusing system which is widely used in modern cameras which can control automatically lens position and can bring the object into focus. Autofocus improves tracking speeds and the focusing becomes more accurate. The autofocussing System are two types

- i) Active
- ii) Passive

The “Active AF” system uses sound waves to calculate the distance. It sends an infrared beam to the object and the bouncing that light back to your camera will calculate the distance between the camera and the object. Once the camera knows what that distance is, it makes the lens to adjust focus based distance.

Active AF is that it can be used in poorly-light environments, and can only use for the non-moving close objects Active AF has problems like it gets confused when taking a picture of light, Black surface will absorb the infrared beam and it may focus on some other object in front of original object.. This Active AF method is expensive and complicated. Passive AF works on the red beam to find out the distance between the cameras and subject which either uses Phase Detection or Contrast Detection or a combination of both for detection of the contrast. The Passive AF is that they are simpler and less expensive than Active AF. Passive AF is widely used in Vision applications.

Active Autofocussing	Passive Autofocussing
Estimates the distance to the image subject without depending on optical system and makes the optical system to focus correctly	Estimates the accurate focus by analyzing the image that enters to the imaging systems.
The picture is taken based on the reflected light from the subject when the subject is incident by a light source	They do not have any light energy as in active autofocussing

Lens is adjusted depending on the reflected light and the distance is measured by means of the infrared light source or the ultrasonic waves	Passive autofocussing can be obtained by contrast and Phase detection
The picture quality depends on the reflected light	

Tab 1: comparison of Active and Passive Autofocussing

Phase Detection is the fastest and accurate method. The image is split into two separate images and two lines on the AF sensor aimed at the two images. If both the lines hit precisely the image is in focus. If the two lines are closer or further apart then the image is not in focus and the focus ring needs to be adjusted. In Phase Detection AF it doesn't work in low light. It may not focus on dark objects and low contrast objects. It can be prone to errors with wide apertures. Micro adjustments of lens are needed. Phase Detection AF is very fast, which makes it ideal for tracking fast-moving subjects. The second type of Passive autofocus system is **Contrast Detection AF**. Contrast Detection is on sensor focus mode. It is slower and less accurate. It is focussed on the pixels on the sensor and adjusts the focus for maximum contrast. The focus box should be placed on the area where there is a good native contrast. Unlike Phase Detection AF that uses hardware, Contrast Detection AF relies on software algorithms. Contrast Detection AF can be much more reliable and accurate compared to Phase Detection AF when capturing in low-light conditions. In some cameras both the Contrast Detection AF and Phase detection AF are incorporated. In such cameras can easily switch between Phase and Contrast Detection AF which helps to take advantage of both in different environments. This type of autofocus detection is known as **Hybrid AF**.

Phase Detection	Contrast Detection
It uses a sensor to determine the image captured is in focus or not	The most accurate and simple method where the image is captured and the contrast is computed
Mirror mechanism system that separates the light entering the lens with the AF sensor	The contrast value decides the focus point.
In phase detection the image hits the prism it separates into two images and if the images line up together the object is said to be in focus otherwise it is out of focus	The feature of the image is based on contrast measurement
	Spatial Domain or Frequency Domain, Edge Detectors or Intensity Variation based, Sharpness function or Smoothness function,

Tab2: Comparison of Phase Detection and Contrast Detection

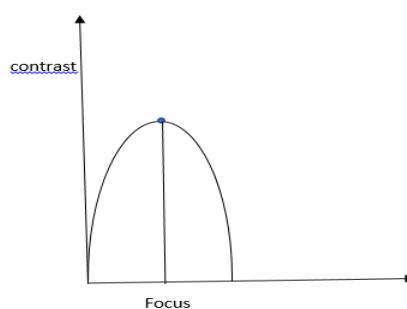


Fig 1 maximum contrast detection

Capturing still objects and where we need a high contrast in a single shot it is better to choose the Contrast Detection. The fast moving object autofocus accuracy and the speed can be achieved by Phase Detection. The contrast and the

Phase detection autofocussing needs enough light for focusing the object. The phase detection or contrast detection is chosen depends on the object to capture.

Types	Merits	Demerits
Phase Detection	Faster autofocussing	System is complex
	It gives more information of image	Subject to false focusing
Contrast Detection	System is less complex than phase	Computation time is more
	Better focusing than Phase detection	It is best only for static objects
	Immune to noise	

Tab 3: Merits and Demerits of Phase and Contrast Detection

II. PARAMETERS INFLUENCING AUTOFOCUSING

1. Focus Points

Focus points are the little empty squares or dots that you see when you look through your lens.. These focus points are in certain parts of the frame and the number of focus points which is necessary for getting accurate results. The Autofocus points are vertical, horizontal and cross type. These three autofocus points can apply only to Phase Detection as the Phase detection rely on hardware sensors.

One dimensional and detecting contrast in one direction is done by vertical and horizontal sensors .the two dimensional which can detect contrast both vertical and horizontal lines by the Cross type sensors. The more accurate Phase detection AF depends on the more cross type sensors in the camera

1. Depth Of Field

Depth of field deals with the distance between the nearest and farthest object in an image that appear acceptably sharp. Depth of Field is the area in an image that is sharp ie it appears to be in focus. The depth of field can be estimated by knowing the focal length, distance to object, the acceptable radius value circle of confusion, and aperture

$$DOF = \frac{2u^2 Nc}{f^2}$$

c- Circle of confusion

F-focal length

N-f-number

U-distance to the object

2 Depth Of Focus

In depth of focus is the distance above and below the image plane over which the image appears in focus. Distance to the object depends on the length between camera and the focus of the image. The depth of field appears to be narrow if the object appears closer to the camera and vice-versa.

2. Focus Modes

Most of the cameras are designed with the focus modes. The three most common modes are single, continuous, and hybrid.

i) Single AF mode

Commonly used AF mode is Single SF mode. A single focus point is used to capture a sharp photo. In single AF mode Camera and object should remain still i.e. the autofocus in “locked” and it won’t be able to capture if the camera and object suddenly moves

ii) Continuous AF mode

In the case of any sports or wildlife photography a continuous AF mode is Necessary. The continuous AF mode camera tracks the object and predicts which direction it's moving in to keep it in focus ie focus readjust continuously.

iii) Hybrid AF modes

In case of we don't know whether to shoot moving objects or stills we can choose hybrid autofocus mode. In Hybrid AF camera will automatically switch between whichever mode is needed. If the camera detects the Movement of the object it automatically use Continuous focus.

This autofocus modes is assigned to a button in camera and it gives the advantages of Convenience, Accuracy and Speed.

AF MODES	Working	Applications
Single AF mode	Camera will lock the focus on the object and if the object moves we need to focus again It is the basic autofocus function	Architecture Still Portraits Landscape
Continuous AF mode	Camera will track continuously even the object moves and the efficiency depends on the object movement and light condition It is the advanced autofocus function	Wild life photography Sports and actions
Hybrid AF modes	The camera switch between single and continuous autofocus modes depending on the object movement.	Unpredicted Movements of the objects Children wild life

Tab 4: comparison of autofocus mode

3. Depth of Defocus

Depth from defocus method uses the direct relationships among the depth, camera parameters and the amount of blurring in images to derive the depth from parameters which can be directly measured. The key problems are the measurement of difference of blurring amount and the calibration of the mapping between depth and the difference of blurring.

III. DEPTH OF FIELD VS DEPTH OF DEFOCUS

- The DFF-type methods are based on the fact that the image formed by an optical system is focused at a particular distance whereas objects at other distances are blurred or defocused
- DFF includes two stages: the first stage is to determine the focus function that describes the degree of focus at different positions
- The second stage is to search and find the best focus position according to the focus function
- DFF methods need to acquire a large number of images at different distances and calculate their focus values, they require long scanning times and high power consumption, which limit their application.
- The DFD method is popularly used in depth estimation and scene reconstruction, which can measure the focal length of image
- DFD methods are mainly based on the power spectrum in the frequency domain or the point spread function (PSF) of the image in the spatial domain
- PSF-To find the accurate sharpness of image PSF is an important parameter

IV. POINT SPREAD FUNCTION

The importance of PSF in autofocussing of an image

- PSF determine the resolution of image
- PSF analyse the out of focus image
- To generate and display aberrated structure of image
- Image degradation can restore by finding the PSF

Lens theorem states that light from a point source passing through the lens system will be converged to a point in the best-focused position. If image plane is not at the best-focused point, the converged point in the plane will be shaped as a circle and is termed as circle of confusion (CoC)

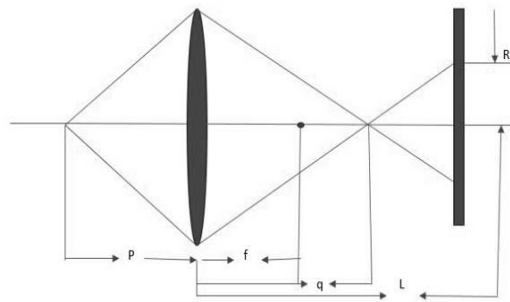


Fig 2: Radius of CoC

q- Image distance

D-aperture radius

L-image plane location from lens

The radius of CoC is given by

$$R = \frac{D}{q} * |L - q|$$

Degree of the focus determine by R and the lesser value of R represent the best focus point.

When the lens is ideal at the energy point of view light source incident on the lens and is considered as one point light source it is given as the total energy on the lens system is also one unit. The brightness inside the circle will be uniform and zero is considered outside.

The lens system response for a point light source is defined as Point Spread Function (PSF).

In ideal case the point spread function is given as

$$\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} h_{ideal}(x, y) dx dy = 1$$

Given h_{ideal}

$$h_{ideal}(x, y) = \begin{cases} \frac{1}{\pi R^2} & \text{if } x^2 + y^2 \leq R^2 \\ 0 & \text{otherwise} \end{cases}$$

Where R is the radius of Coc.

In practical case PSF is modified and is given as

$$h_G(x, y) = \frac{1}{\sqrt{\pi R^2}} e^{-\frac{x^2 + y^2}{R^2}}$$

When considering the image through the lens system the PSF can be calculated as $I(x, y)$ is the original image, $h_G(x, y)$ is the PSF value, (x, y) is the observed image, $*$ is the convolution operator.

$$G(x, y) = I(x, y) * h_G(x, y)$$

The measured PSF can be applied to suitable filter to reconstruct the original image and help to identify the amount of blurring in the image. The out of focus blur can be estimated using PSF. Blur is encountered in the autofocussing application and can be removed using the estimation of the PSF. By introducing additional blur reduces the effect of noise in blur estimation within an acceptable range of blur and noise value and is given by

$$G(x, y) = I(x, y) * h_G(x, y) + n(x, y)$$

Where $n(x, y)$ is the noise

In this case the PSF or the blur can be calculated using De-convolution method.

V. CONCLUSION

In this paper we discussed the autofocussing methods, autofocussing modes and the parameters which effects the autofocussing. PSF is an important parameter in autofocussing system as it determines the blur occurred in the image and also calculates amount of blurriness occurred in the image. When considering autofocussing applications the one who determine image in focus with improved accuracy the PSF plays a vital role and the PSF can be computed using various autofocussing algorithms such as Mountain Climbing, Exhaustive Mountain climbing, Histogram algorithm, Adaptive step size mountain climbing, Focus curve estimation etc. The autofocussing can be done using an image gradient but the blurring of the image cannot be calculated. So to calculate the blurring of an image the PSF estimation is an important parameter to determine the accurate focus point.

REFERENCES

1. LI-CHENG CHIU AND CHIOU-SHANN FUH," An Efficient Auto Focus Method for Digital Still Camera Based on Focus Value Curve Prediction Model "in JOURNAL OF INFORMATION SCIENCE AND ENGINEERING 26, 1261-1272
2. Dippal Israni, Sandip Patel and Arpita Shah," Comparison of Different Techniques of Camera Autofocusing", <https://www.researchgate.net/publication/304621499> F. Rooms, M. Ronsse, A. Pizurica, W. Philips," PSF ESTIMATION WITH APPLICATIONS IN AUTOFOCUS AND IMAGE RESTORATION", Proc. IEEE Benelux Signal Processing Symposium Leuven, Belgium
3. Yalin Xiong and Steve Shafer, "Depth from focusing and defocusing," in Proc. of IEEE Conf. on Computer Vision and Pattern Recognition Liao, W.-S., Fuh, C.-S.: Auto-focus. In: CSIE
4. Subbarao, M., Tyan, J.-K.: Selecting the optimal focus measure for autofocusing and depth-from-focus. In: Pattern Analysis and Machine Intelligence, IEEE
5. WIKKY FAWWAZ A M, TAKUYA SHIMAHASHI, MITSURU MATSUBARA, and SUEO SUGIMOTO," PSF Estimation and Image Restoration for Noiseless Motion Blurred Images", Proceedings of the 7th WSEAS International Conference on Signal, Speech and Image Processing, Beijing, China
6. Charles Herrmann¹ Richard Strong Bowen¹ Neal Wadhwa² Rahul Garg² Qiurui He² Jonathan T. Barron² Ramin Zabih¹, "Learning to Autofocus" Computer vision foundation published in IEEE xplore
7. C.Chan, S. Huang, and H. H. Chen. Enhancement of phase detection for autofocus. ICIP, pages 41–45, Sep. 2017.
8. Sumon Dey, Ratnakirti Roy ¹Department of Computer Applications, Inspiria Knowledge Campus, Siliguri, India." Autofocus Technologies in Digital Cameras: A Comparative Study", Inspiria Excellence Series Multidisciplinary Conference on Future Paradigms in Industry, Inspiria Knowledge Campus, Siliguri (ICFPI-2018). Nov 01-02, 2018



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