

Technology migration in photography general education: from camera to mobile phone

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Abstract: Camera and photography techniques are a general education course, and photography practice tools of this course have undergone changes from traditional cameras to digital imaging system. Nowadays, mobile phones are more and more widely used as photography tools, and more students will use mobile phones for photography practice. This paper summarized the technical characteristics of traditional cameras and digital imaging system, and analyzed the technology migration from camera to mobile phone. After understanding the technology differences of photographic tools, students can better apply what they have learned to practice.

1. Introduction

Photography is both a science and an art; it is an important means of information dissemination. Photography widely used in various fields of human society. With the development of digital imaging technology and image processing technology and the arrival of the information age, the role of photography in information dissemination is becoming more and more important. At the time of deepening education reform, the education undertakes the task of training high-quality laborers and specialized talents with moral, intellectual, physical and aesthetic development in a prominent position. Therefore, photography teaching plays an important role as part of quality education [1].

Camera and Photographic Techniques general course of Zhejiang University began in the 1980s and has been in existence for forty years. Teaching content has shifted from traditional camera photography to digital camera photography, and the changes of the photographic tools for course practice are given in the appendix of this article (since 2006). At present, the application of mobile photography is more and more extensive [2]. As a latecomer, mobile photography has inherited many digital imaging technologies from camera photography, and at the same time, it has made great progress in combination with the characteristics of mobile phones [3]. After completing this course, more students will use their mobile phones as a photography tool, so comprehending of the technical migration characteristics from camera photography to mobile photography will help students to apply the course knowledge.

2. Technical characteristics of traditional camera

The structure of a traditional camera is shown in Figure 1. The camera's main body is the structural basis of the entire camera and is the overall structural frame of the camera. It determines the layout of the camera, fixing the functional component of the camera such as the lens, shutter, viewfinder, winding system, circuitry, etc. It holds the film together with the camera back cover and forms the imagery black box space between the lens and the film. The control circuit system is the brain of the camera. All the automation functions, the working mode of the camera, and the working logic are controlled by the circuit system. Many complicated cameras use CPU (central processing unit) technology to realize the digital processing and control of photoelectric information.

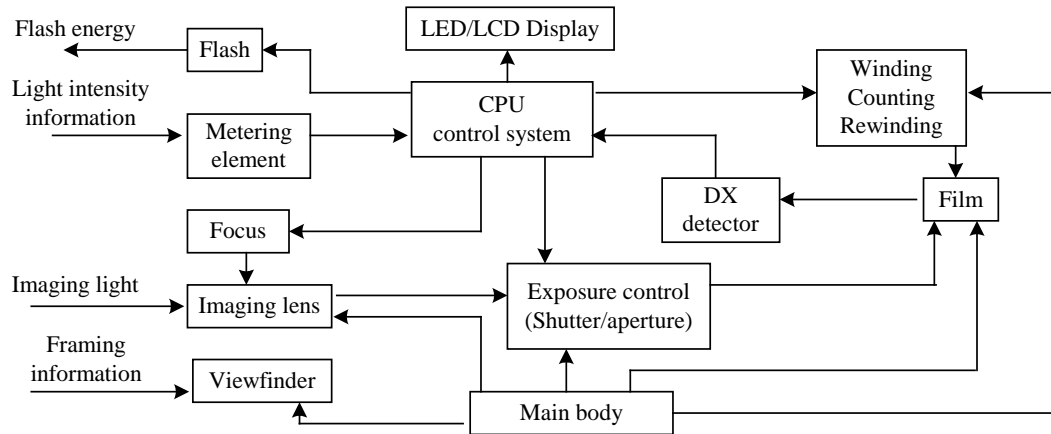


Figure 1 The structure of traditional camera

The function of the imaging lens is to receive light from the object and correctly obtain image of object on the plane of the film. The exposure control system acquires the light intensity information of the object by the photometric component, and the CPU analyzes the exposure parameters and controls the shutter speed and the aperture size to enable suitable light energy passing through the lens imaging system.

The focusing device of camera, such as single-lens reflex (SLR) camera, is closely related to the viewfinder. The autofocus system acquires the focus information by the focus detector, and the CPU implementing control commands to adjust the position of the lens.

The winding, counting and rewinding system is the necessary structure to complete the shooting of the entire film. The winding method has been developed from the form of hand wheel to the micro-motor automatic winding and automatic rewinding modes. The automatic winding, rewinding and counting operations are completely controlled by the circuit.

In the system structure of the traditional camera, some structures and functions may vary depending on the type of camera and the grade. However, the main body, imaging lens, viewfinder and shutter are the most essential elements that make up the camera.

3. Technical characteristics of digital imaging systems

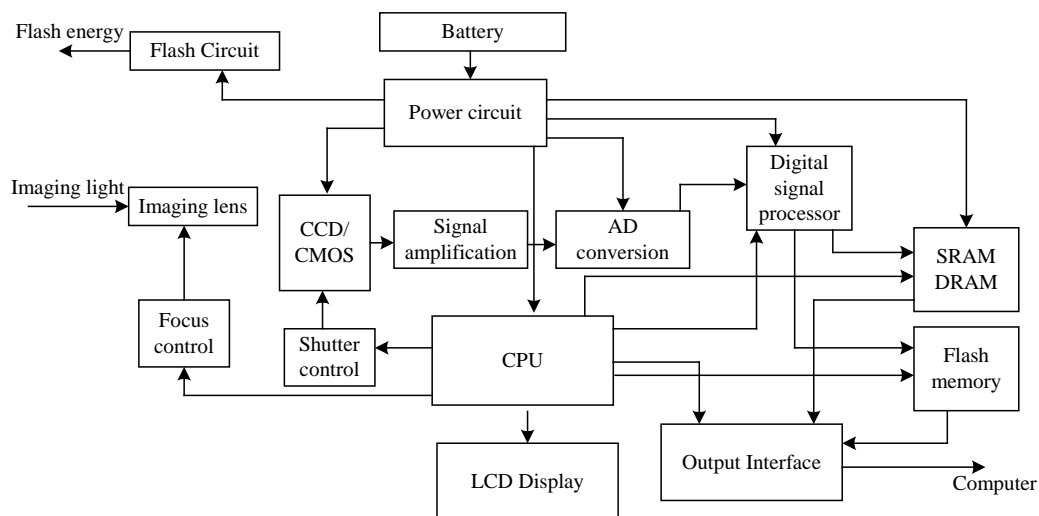


Figure 2 The structure of digital imaging system

The basic system structure of the digital imaging system (including mobile phone) is shown in Figure 2. In general, system records the image of an objective scene on an area array photoelectric detector (CCD or CMOS) through an optical imaging system, and controls the luminous flux and

photoelectric saturation current through a mechanical or electronic shutter to obtain suitable image exposure information. The subsequent circuit processing section acquires information on the photoelectric detector by parallel or serial scanning, and forms a digital image by analog signal amplification, analog to digital conversion. The image file is then processed and compressed by a DSP (Digital Signal Processor) circuit. The obtained digital image information can be displayed on the LCD screen or stored in various specifications of storage media. The imaging system can also transfer digital image information to the computer through the output terminal; all functions, operating procedures, and operational timing of the digital imaging system are controlled by the CPU.

Many digital imaging systems are equipped with optical viewfinder and built-in automatic flash, have autofocus function and image information transmission function.

4. Technology migration from camera to mobile phone

In essence, the mobile phone is also a digital imaging system. In the era of single-imaging-module, mobile phone photography is mainly focused on improving image resolution, and the resolution of mobile phone image sensors was quickly increased to more than 10 million pixels [4]. Due to the limitation of a thin profile of mobile phone, further improvement in resolution (more than 20 million pixels) of the mobile phone does not effectively improve the image quality [5].

Single-module phone is just a miniature version of a digital camera, while mobile phone with multi-module is fusion of multiple intersections such as computational photography, computer vision, optics, and photography aesthetics. Integrating optical digital hybrid imaging technology, the imaging quality of mobile photography is gradually approaching the imaging effect of digital SLR cameras. Using a grayscale module and a color module to capture more details, mobile camera can acquire better imaging effect; using two color modules to take pictures at the same time, mobile camera not only can get twice the amount of light energy, but also can record the depth of field information of the object; using a wide-angle module and a telephoto-module mobile camera can achieve smoother zoom.

As one of the most popular photography tool, mobile phone cameras are inseparable from the photographic elements such as aperture, shutter, exposure, focus, etc., but the technical content of various elements have undergone tremendous changes. The mobile phone inherits some technologies from the camera, and also develops a series of new methods. For example, the PDAF (Phase detection autofocus) in SLR camera requires a splitting mirror, two lenses and two line array CCDs, which are complicated in structure and are not suitable for portable devices such as mobile phones. Since the mobile phone needs a thin profile and cannot introduce a splitting lens, the some pixels in the imaging detector are used to split the light, that is, these pixels in the photosensitive area are sacrificed. These are called Masked Pixels and are used in pairs[6]. The distance between pixels and their relative changes can be used as an indication of focus. The masked pixels are selected in pairs, as shown in Figure 3, the left pixel only captures the left image, and the right pixel only captures the right image. The left and right images are compared to determine the amount and direction of movement of the lens.

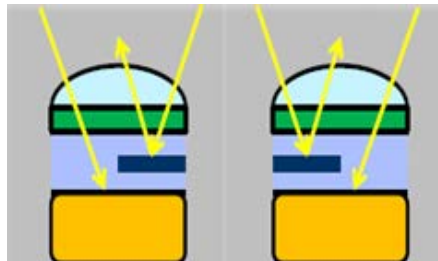


Figure 3 Imaging principle of masked pixels

Two separate photodiodes are made in each pixel and correspond to the same microlens. The two photodiodes operate independently during phase detection and be read as a pixel during imaging.

PDAF is only one aspect of technological change; we summarized the migration of various

technical features from camera to mobile phone as shown in the Table 1.

Table 1 Technology migration from camera to mobile phone

Technology field		Traditional camera	Digital camera	Mobile camera
Aperture		Variable depending on lenses	Variable depending on lenses	Aperture is fixed
Shutter speed		Manual or auto-control	Manual or auto-control	Auto-control
Exposure		Manual or auto-control	Manual or auto-control (can adjust the exposure through post processing)	Auto-control (can adjust the exposure through post processing)
Framing		Optical viewfinder	Optical viewfinder or LCD viewfinder	LCD viewfinder
Zoom		Choice focal-length from wide angle to telephoto (depending on lenses)	Choice focal-length from wide angle to telephoto (depending on lenses)	Fixed focal-length wide angle lenses (some mobile phones have a wide-angle lens and a telephoto lens to achieve smoother zoom)
Depth of field		Can be altered by changing the aperture/focal-length and visualized using depth of field preview	Can be altered by changing the aperture/focal-length and visualized using depth of field preview	Cannot be altered (some mobile phones can alter DOF using dual lens systems)
Autofocus	Based on raging	Using PSD	-	-
	Contrast analysis	-	mountain-climb searching	mountain-climb searching
	Phase Detection	Using line array CCD	Using line array CCD or masked pixel	Using masked pixel

5. Conclusion

From the birth of 19th century photography to the present, photography tools have undergone tremendous changes, and mobile phones have become the most popular photographic equipment. For the user, photography is always inseparable from lens aperture, shutter, exposure, focus, etc. The goal of technological advancement is to better serve people, which is also the goal of photography general education.

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Appendix: Photographic tool statistics for course practice

Semester	Number of student	Photography practice tool
2006-2007 winter	101	Tranditional camera
2006-2007 spring	103	Tranditional camera
2006-2007 summer	100	Tranditional camera
2007-2008 winter	100	Tranditional camera, portable digital camera
2007-2008 spring	101	Tranditional camera, portable digital camera
2008-2009 winter	101	Tranditional camera, portable digital camera
2008-2009 spring	112	Tranditional camera, portable digital camera
2009-2010 winter	100	Tranditional camera, portable digital camera
2009-2010 summer	100	Tranditional camera, portable digital camera
2010-2011 winter	99	Tranditional camera, portable digital camera
2010-2011 spring	121	Tranditional camera, portable digital camera
2011-2012 winter	120	Tranditional camera, portable digital camera
2011-2012 spring	153	Tranditional camera, portable digital camera
2012-2013 winter	133	Digital SLR camera, tranditional camera
2012-2013 spring	134	Digital SLR camera, tranditional camera
2013-2014 winter	148	Digital SLR camera, tranditional camera
2013-2014 spring	151	Digital SLR camera, tranditional camera
2014-1015 winter	127+91(two classes)	Digital SLR camera, tranditional camera
2014-1015 spring	138	Digital SLR camera, tranditional camera
2015-2016 winter	114	Digital SLR camera, tranditional camera
2015-2016 spring	128	Digital SLR camera, tranditional camera
2016-2017 autumn	130	Digital SLR camera, mobile phone
2016-2017 spring	122	Digital SLR camera, mobile phone
2017-2018 autumn	152	Digital SLR camera, mobile phone
2017-2018 spring	153	Digital SLR camera, mobile phone
2018-2019 autumn	118	Digital SLR camera, mobile phone
2018-2019 spring	130	Digital SLR camera, mobile phone