Introduction to Manual Photography for Beginners

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Abstract

This document is an explanatory supplement for our interactive visualization project. Our project aims to create a clear and easy to understand visualization for photography beginners to learn how to manually adjust the four main functions of a digital camera, including aperture, shutter speed, ISO, and exposure. By using HTML, CSS, and JavaScript, we design an interactive instruction to help beginners pick up the basic photography skills quickly.

***Index Terms*—** manual photography, interactive visualization, beginner, aperture, shutter speed, ISO, exposure

I. INTRODUCTION

The most common problem for photography beginners is to take control of their camera. To capture better photos, the first lesson is to learn how to manage exposure. Aperture, shutter speed, and ISO are the three important elements that affect the exposure of the photos. Most of the instructions of photography for beginners are either text-based articles or only include still images, our team noticed that article and still images are both not the best approach for beginners to memorize and understand to concept of those functions. Thus, we want to create an interactive website to show the users how to adjust aperture, shutter speed, and ISO. Apart from exposure, those functions can also result in the depth of field, motion blur, and digital grain.

Our project is divided into four sections. The first three sections are the aperture, shutter speed, and ISO. These three sections aim to show the individual effect of each function and also the influence on the exposure. The last section combines the three components to show how these three tools control the exposure of the photos.

II. RELATED WORK

As we have mentioned, photography instructions for beginners are usually blog articles or still images. We also found some infographics named “photography cheat sheet” that are visualization works related to our project (fig. 1).

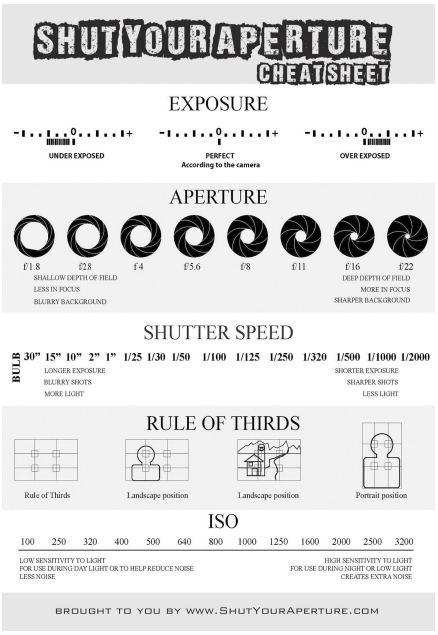

Fig.1. The photography cheat sheet from https://www.shutyouraperture.com

These photography cheat sheets summarize the concept of photography into one single infographic, containing the effects of aperture, shutter speed, ISO, and exposure. Fig.1 is one of the cheat sheet examples. It explains how aperture affects the depth of field and blurry background, how shutter speed changes the exposure, and how ISO change the sensitivity to light. Although these photography cheat sheets are useful, we found out that one single still visualization is not good enough for beginners to memorize all the concepts. Also, users are not able to really experience the effects to the photos. Apart from the cheat sheets, we also refer to other articles to understand how others use text to explain the principle of photography.

The blog articles and infographics motivate our team to create an interactive visualization to teach photography beginners in a more intuitive way.

III. METHOD

Since our team decided to create web pages, the primary tools of this project are HTML, CSS, and JavaScript.

HTML helps us to create the basic structure of our web pages and CSS is used to manage the formatting and layout by assigning different properties to HTML tags. We also use other tools to generate the detail of our webpage. Our design includes a lot of illustrations, using Adobe illustrator allows us to make a draft of our illustration and we are also able to translate the illustration into SVG files. Last but not least, JavaScript help us to control the interactions and behaviors of the elements.

IV. RESULTS

In this project, we break down the topic manual photography into four small concepts which are the four most important and most confusing elements to the beginners. To better illustrate these concepts, we add different animations to show the changes of aperture, shutter speed, and ISO based on their various definitions. And finally, we make a exposure calculator to show the relationships among these four, and enables users to calculate the exposure values and light values using the combination of the values of aperture, shutter speed, and ISO as a conclusion.

General Structure

We have five separate pages as each concept is illustrated individually on its own page to avoid confusion along with a homepage. All four pages include the global navigation area to help users switch to other pages, concept title of this part and explanations of the concept in text messages to give users basic definitions and the background knowledge to understand our interpretations.

We organize the sequence of the pages starting with aperture, shutter speed, ISO, then finally exposure following the how the lights get into the camera controlled by the built-in equipment and settings of a camera. It is a process of sensing and capturing light. This is how it works: aperture is the diameter of the hole inside the lens which is the outermost component exposing directly to the lights. After the lens

lets light into the camera, the mirror flips up and the shutter open, recording the light onto the sensor(or film). Then the sensor captures the light and is controlled by the ISO.

Aperture

The aperture controls the opening of the lens 's diaphragm through which lights pass. The aperture number is marked as f/stops, and the number could be 1.4, 2.8, 8, 13 and so on. The lower f/stops lead to more exposure due to the wider lens of the camera and allow more lights to pass through. On the other hand, the higher f/stops give less exposure because they represent smaller apertures. To put it simply, the lower the f/stop—the larger the opening in the lens—the less depth of field—the blurrier the background, and vice versa.

The aperture also affects the depth of field which means how sharp or blurry is the background in the photos. In our example photo, the mountains in the background will change from blur to sharp depending on the aperture setting. In addition to the depth of field, aperture also changes the exposure of the photo. Our design also allows users to learn that wider lens leads to greater exposure.

To show how aperture changes the photos, we design a camera with changeable lens and the corresponding photos and also select 8 common aperture setting from low f/stop to high f/stop. The eight settings we select are 1.4, 2.8, 4, 5.6, 8, 11, 16, 22, which are the most commonly used full-stop f-numbers while we ignore the one-half-stop or one-third-stop f-numbers. Instead of having slider bar or other design, we design 8 buttons assigned to each aperture setting because the numbers are not continuous and have different ranges of intervals between them. By clicking the buttons, the lens and the photos will change at the same time to show the result of each aperture setting. Fig. 2. shows the interface design of our aperture section.

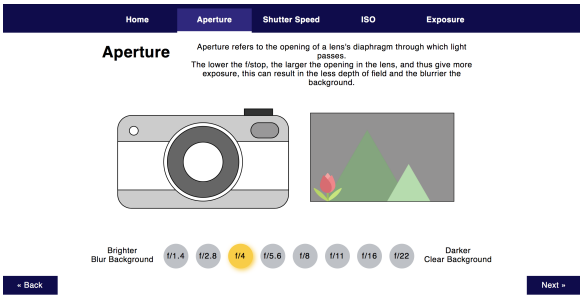

Fig. 2. The interface design of aperture section

Shutter Speed

Shutter speed is the length of time the camera shutter is open, exposing light onto the camera sensor. To be direct, shutter speed is responsible for changing the brightness of a photo and creating dramatic effects by either freezing action or blurring motion. Therefore, we put a photo composed of two parts, the object(a car) and the background, in accordance to the two things controlled by shutter speed. When users click on the buttons showing different shutter speed values, they will trigger the change of both the car and the background simultaneously. The faster the shutter speed is, the more freezing motion it captures with a darker background; while the slower the shutter speed is, the more blurring motion it captures with a brighter background. We use CSS Gaussian blurring filter and adjust its standard deviation parameter to get clearer or blurrier effects. As for the background,

we choose to use the single color hue with lighter or darker grey instead of a real picture to represent the change of lightness because we think using a single-colored background can minimize other interferences and keep users' concentrations on the background itself.

Shutter speed ranges from the fastest 1/4000 second to the slowest 30 seconds. Among all, 1/2 to 1/1000 are both the most commonly used range and are in accordance with the full-stop f-numbers we choose for the aperture values. We pick all ten shutter speed values within this range, they are:1/2 , 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000 second. And similar to the aperture part, we use buttons to represent these discrete values.

To emphasize the context where shutter speed matters, in the beginning, we add an animation which includes the car movement and the flash of a camera, trying to mimic the situation when a person is taking a photo for a moving car.

Also, we consider another problem that might interest the photography beginners, whether hand-holding or using tripod in filming. This is merely relevant to the shutter speed because the longer time the shutter opens, the higher chance the screen will be influenced by shake. Though there is no certain rule that under which shutter speed a photographer should use hand-holding or tripod, we refer to common sense assuming that beginners do not have strong expertise in holding a camera steadily. Therefore, 1/60 second, the minimum hand-holding speed using a camera equipped with a 60mm lens, has been taken into consideration as the limitation of doing hand-holding; a photography beginner should always consider using a tripod to avoid shaking if slower than this shutter speed. We choose images of tripods and hands along with text messages to visualize these options. Fig.3. shows the design of our shutter speed section.

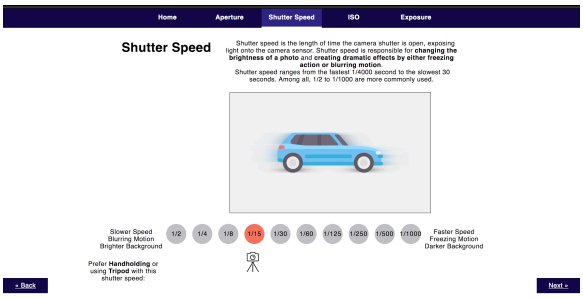

Fig.3. The interface design of the shutter speed section

ISO

Another function that can dramatically affect exposure is the ISO, this function help users to capture images in dark environment or be more flexible about the aperture and shutter speed setting. The ISO simply stands for the International Organization of Standardization, which is the standard of sensitivity ratings for digital camera sensors. When users change the ISO on a digital camera, users are rendering it more or less sensitive to light. As users turn the ISO number up, the exposure increases but, at the same time, the image quality decreases with more digital noise or "grain". Typically, the most common ISO settings of digital cameras scale between 100 to 6400 or greater, each setting differs by a factor of two, the greater number of ISO means higher sensitivity to light.

The high sensitivity allows us to take better photos in the darker environment but the image that taken in higher ISO tend to have much more noise (or grain) than the photos at lower ISO. This is why low ISO is always recommended to get the highest image quality.

We use the light bulbs to represent the lightness of the environment and the number of dots represents the degree of noise (or grain) of the photos. To make our instruction more clear and easy to remember, the ISO setting is divided into low, medium, high ISO with tips showing below. Also, we change the background color from bright to dark corresponding to low and high ISO, since we believe that this design can help beginners to memorize the suitable lightness for each ISO. The actual interface design is shown in the Fig.4.

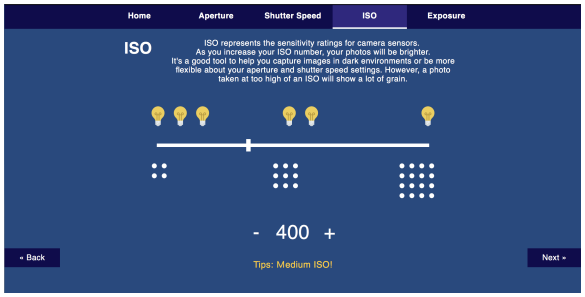

Fig. 4. The interface design of the ISO section

Exposure

In photography, exposure is the amount of light per unit area reaching a photographic film or electronic image sensor, as determined by shutter speed, lens aperture, and scene luminance.

As our last part, we integrate three previously mentioned elements into this exposure calculator to get the accurate numbers, so as to compensate for the non-quantitative methods in the previous parts. In this process, we ignore other irrelevant factors such as scene depth or blurriness but focus on the exposure aspect. The idea of creating a calculator is inspired by the existing exposure meter which contains too many combinations and is hard to read. A dynamic calculator displaying only the certain values calculated based on combinations of the user's choice is more useful.

An exposure value (EV) is the exposure settings on your camera a combination of a camera's shutter speed and aperture f-numbers. Each Exposure Value, or EV, represents any of many different but equivalent combinations of f/stop and shutter speed. A light value (LV) is a measure of the luminance of a scene,refers to how bright the subject is.

To calculate these two values, aperture, shutter speed, and ISO settings should all be translated into actual numbers because the camera settings are always marked with nominal values for better memorized by people, but they use their actual precise values. The f-number is the focal length divided by the diameter of the aperture. Most modern lenses use a standard f-stop scale, which is an approximately geometric sequence of numbers that corresponds to the sequence of powers of the square root of two. All the aperture we choose can be represented in this way: the n in f/n equals to the (n-1) powers of square root of 2, for example, 1.4 means the 1 power of square root of 2. Therefore, to be more correct in the calculation, we transform the aperture using the formula mentioned above and keep the value

rounded to three decimal places, for instance, 1.4 becomes 1.414, 2.8 becomes 2.828, and so on. As for shutter speed, the differences of nominal values and precise values also exist following the rule of powers of 2. For instance, the nominal values of shutter speed full stops are shown as 1/2, 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000,while the actual values should be 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256, 1/512, 1/1024. Hence the actual values are converted into the following decimal values: 0.5, 0.25, 0.125, 0.0625, 0.015625, 0.0078125, 0.0039063, 0.0024608, 0.0019531, 0.0009766.

Furthermore, given that our target readers are beginners, we do not want to overwhelm them by complicated numbers without showing contexts or results. So, we add the light values, and a table of light values and corresponding situations where they should be used. Light values are usually measured under the ISO 100. Though the light value is not standardized or widely accepted compared to the exposure value, it still gives users more intuitive and practical senses of the exposure concept.

The formula we use for calculation:

(1) Aperture Value (AV) = √2^(n-1)

(2) Equivalent Exposure (EV) = Log 2 (AV ^2 / shutter speed)

(3) Light Value (LV) = (log2 (aperture * aperture / shutter speed)) + log2 (ISO / 100) =EV+log 2 (ISO/100)

Table I
F-NUMBER, NOMINAL AND ACTUAL APERTURE VALUE

F-number	Nominal Aperture Value	Actual Aperture Value
f/1.4	1.4	1.414
f/2.8	2.8	2.828
f/4	4	4
f/5.6	5.6	5.657
f/8	8	8
f/11	11	11.314
f/16	16	16
f/22	22	22.627

Table II
NOMINAL VALUE,ACTUAL VALUE IN FRACTION AND DECIMAL OF SHUTTER SPEED

Nominal Value	Actual Value (Fractal)	Actual Value (Decimal)
1/2	1/2	0.5
1/4	1/4	0.25
1/8	1/8	0.125
1/15	1/16	0.0625,
1/30	1/32	0.015625
1/60	1/64	0.0078125
1/125	1/128	0.0039063
1/250	1/256	0.0024608
1/500	1/512	0.0019531

1/1000	1/1024	0.0009766

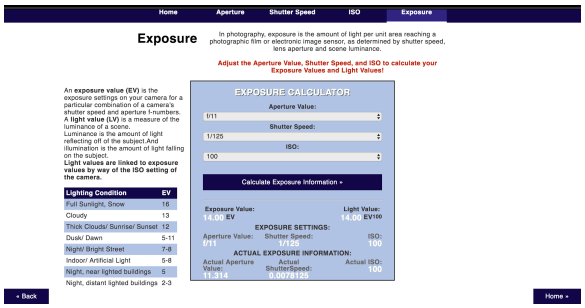

Fig. 5. The interface design of the exposure section

V. DISCUSSION

The setting of the digital camera is quite complicated. In different environments, photographers need to combine different settings to take a perfect photo. Since the functions always interact with each other, the idea to separate each function into four functions lead to some confusion in the initial stage of our design. At first, we wanted to include suggestion setting for all situation, for instance, taking photos at night, indoor, sunny day and so forth. However, it's impossible for us to design a web page to include all the situation. Thus, we turned to only focus on the effects of each function and explain the results of adjusting those functions. We believe that focusing on the effects of each function is more beneficial for photography beginners in a clear and easy to understand approach.

It is difficult to illustrate the light change using single color hue. In aperture part, the next f-number is always two times smaller than the previous one, which also means the amount of light going through the lens is four times less. However, not only it is nearly impossible to find a color that is four times, sixteen times or even a thousand times darker than another one, but also people cannot tell how much the difference two colors are. Therefore, we just use darker or lighter grey color to show the general trend of light change. This is also the case of shutter speed.

It is also challenging to quantify some factors such as the scene depth and the blurriness of a motion as we can only show the overall change rather than showing every accurate nuance.

Exposure is a very difficult concept. We cannot explain this complex concept thoroughly from our perspectives as beginners and learners. Though we decided to explain exposure through exposure value, there is another important function known as exposure compensation which is a built-in function for many digital cameras today. We did want to include this, but it is not so standardized as the exposure value for it depends heavily on contexts and users' judgment or preferences towards lightness. Building on the current work we have done, we can think about other ways to include the exposure compensation.

VI. FUTURE WORK

In this project, we only focus on the four crucial functions of photography, aperture, shutter speed, ISO, and exposure. To take a perfect picture, there are more to learn after skilled in those four main elements. Other advanced functions of cameras can also be considered an extension of our project, some of the advanced functions could be metering modes, shooting modes, white balance, polarizing filters and so on. We hope to

work on other advanced function in the future to benefit more photography learners.

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