Project Report: Clarified Moon Surface Photographing Composition

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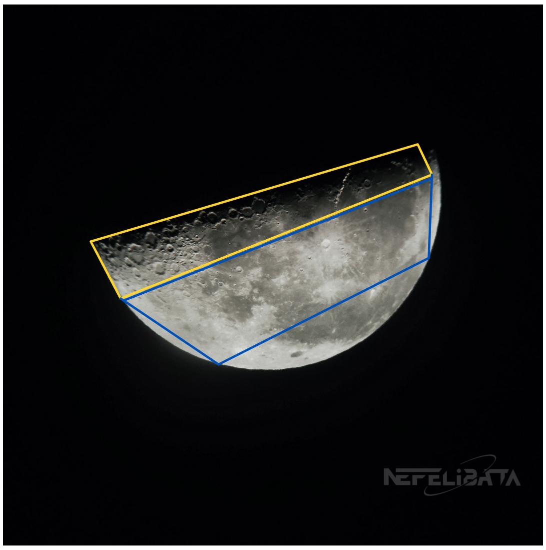
1 Project Introduction

1.1 Problem Targeting

Moon has always been a wonder to humans, and ever since ancient times, people have drained their efforts to observe the moon. However, though equipments have developed over time, and we can now take detailed photos of the moon's surface, there still remains the problem that we can not take down every detail of the moon's surface all at once. As the moon's relative position to Earth alternates, the shaded area will shift, so part of the surface facing us is always unclear. What's more, if the light directly reflects off the moon's surface to us, we also cannot tell the difference in altitude since every part of the surface appears to be white. In order to solve the problem, we need to observe the moon's surface at different period of phases, and compose the photos' clearest part together to generate a clear photo of the moon's surface.

1.2 Procedure

The clearest part of the moon's surface is always at the boundary of the illuminated portion to the dark portion of the moon. As shown in Fig.1(a) below, the illuminated area casts shadow upon the mountains and valleys at the intersection with the darker area, so the landscape in the yellow region can be clearly recogonized. However, light is directly reflected off the ground in the blue region, so the topographic features is very ambiguous.



(a) The Demo for photo of moon's surface.

(b) The selected cycle of moon phases.

Figure 1: Photos taken of moon.

During the research, we cooperated with 11 other schools all over China and take pictures every night, whenever the moon is visible. As weather differs across the country, there are seldom situations that no photo is taken. After 2 months of accumulation, we get a serie of moons in different phases, over 200 photos in total. We picked out similar ones, as shown in Fig1(a) above, and process them to combine the clear parts of the photos into one.

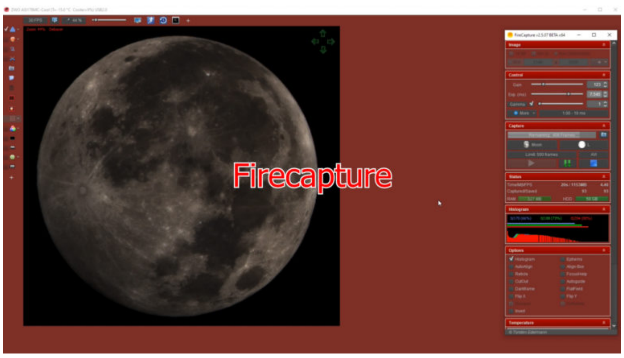
2 Data Collection and Processing

2.1 Photographing Methodology

To ensure that photos taken all over the place can be effectively combined, the format of the photos taken need to be the same with each other. To unify the format, all schools used electronic eyepieces **ZWO**(Fig2(a)) as a camera, and used the **CELESTRON telescope**(Fig2(b)) with model number STL-127. To unify the image resolution, we used the software **Firecapture**(Fig2(c)) to take photos, which can be directly connected to the electronic eyepieces.

(a) ZWO electronic eyepieces

(b) CELESTRON telescope STL-127



(c) Firecapture

Figure 2: Experimental apparatus

2.2 Stacking the photos

After selecting the most appropriate photo of each phase (Fig1(b)), we put them together in Photoshop. We use the auto align function to make the moons in the photos fit each other in scale and position, so the photos will not be messed up. Then, we process each of the photos to adjust their contrast, saturation, richness, and gamma value, so that each photo will cast the same amount of influence of the final value of brightness on each portion of the photo(Fig2.2). The tools are mainly used as listed below:

- One effective tool is the ”Levels” tool, which allows for adjustment of the overall brightness and contrast of the image. This enhances the details in the moon’s surface and make the image more visually appealing.
- Another useful tool is the ”Curves” tool, which allows for fine-tuning of the tonal range of the image. This adds depth and dimensionality to the moon’s surface, making it look more lifelike.
- Utilize the ”Dodge” and ”Burn” tools to selectively lighten and darken specific areas of the image. This draws attention to certain features of the moon’s surface and add visual interest to the image.
- Use the ”Clone Stamp” tool to remove any blemishes or distractions from the image. This creates a more polished final result.

Then, we convert the processed photo into a smart object, and used the standard deviation function(Fig2.2) in the stacking mode.

$$Lv_{pixel} = \frac{\Sigma(Li - L_{avearge})^2}{N_{stacked}} + L_{avearge} \tag{1}$$

Where Lv is the final luminosity of a pixel, Li is the luminosity of this pixel in each photo, $Lv_{average}$ is the average luminosity of the pixel in all photos, and Ns is the total number of photos stacked.

This mode stacks the photos and amplifies their features of surface, while maintaining the fluency of the transformation of color and brightness throughout the photo.

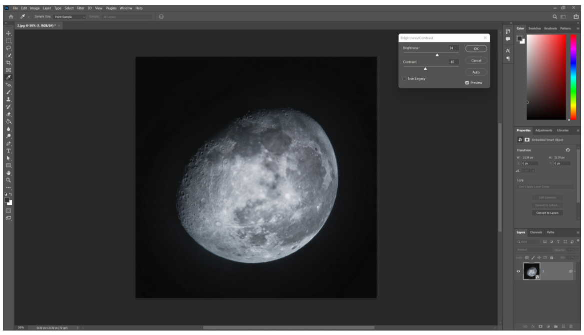


Figure 3: Processing photos

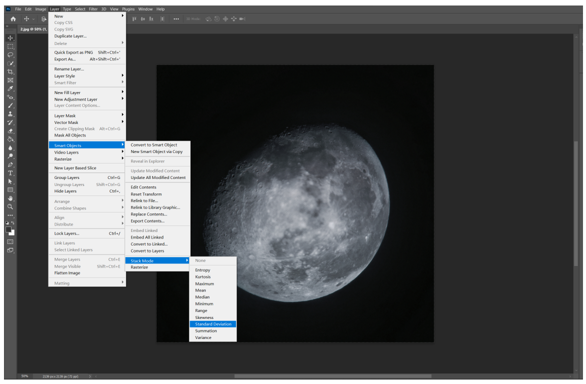


Figure 4: Stacking photos

3 Result

After stacking the photos, we end up with a photo showing relatively clear features of the moon surface’s topography(Fig3). The mountains and craters can be clearly seen, but the edges are still a bit ambiguous, which is the goal for our later improvements.

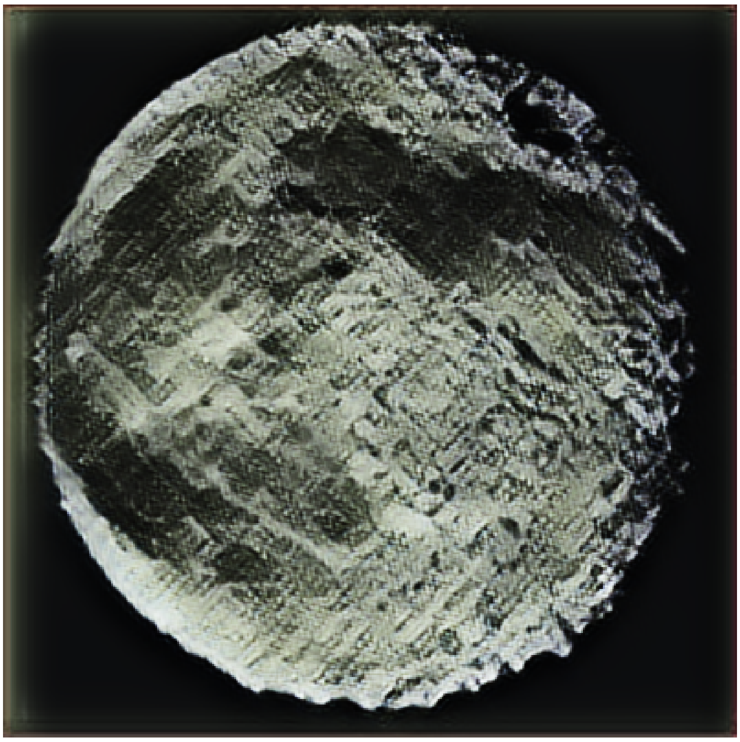


Figure 5: Stacked result photo of moon's surface

4 Evaluation

4.1 Strength

- Photos taken all over the country, so a complete phase cycle is detailedly recorded. The transformation of the intersection between the bright and dark portions gently swept across moon's surface, so the photos taken do not change abruptly, making the result more reliable.

- No extremely complex apparatus or algorithms involved, so the research process can be easily repeated.

- Photos taken have at least 2000×2000 resolvance, making the photo high-qualitied, and allows for minor errors during processing.

- Similar apparatus are used, and same configuration of telescopes are set. This makes the moon's position in the photo taken relatively fixed, which makes it easier to align and process.

4.2 Weakness

- The photos are not taken at the same time, so due to the change in position of the moon, the luminosity of different position on the surface also varies.

- The environmental light emitted from city buildings will also affect the photos taken, making them more yellowish.

4.3 Improvements

- The time for photographing can be agreed upon, and connect the telescope to the network, enabling one person to access control of all telescope, making it more efficient and easier to configure the settings.
- The place for photographing may be chosen at a relatively dark region, blocking out any light that will lead to errors.

5 Reference

References

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