Smartphone Cameras

How to Maximize Image Quality and Color Accuracy

COLOR 20
get the answers here

Presented by
Ford E. Lowcock
Photographic Services to Education and Industry
….Before we get started….

- **Note:** I have an iPhone, so this talk will be skewed in that direction. There are too many variables of the Android phones. Each manufacturer seems to have a different camera and possibly sensor. However, I feel that the results that I address here would be similar on most Android phones.

- **Note:** This presentation is about incorporating Adobe products into the process and not looking at other software i.e. Capture One.

- **Note:** This presentation is about RGB – photographic issues surrounded by color management.

- **Disclaimer:** This presentation is about practical results and applications and is not meant to be a scientific research or presentation.
Resource for many phone cameras

For scientific testing on mobile phones and comparisons. Note: While not directly stated, I believe that testing is completed with the native cameras in the various manufacturer’s phones for their analysis’ and not comparing various capture apps and their differences.

https://www.dxomark.com/category/smartphone-reviews/
Resource for many phone cameras

For hands-on review of the camera’s on many different manufacturers devices and is a sister company to DxOMark

https://www.dpreview.com/connect
The topic of this session may sound unique, but it is not!

Electronic Imaging.org is deeply involved

Dietmar Wueller; Image Engineering is deeply committed and sits on the ISO Committee on this issue. Some of the ISO Standards they have created:

- Exposure (ISO 12232 [6])
- Dynamic range and noise (ISO 15739 [7])
- Detail Reproduction (resolution) (ISO 12233 [8])
- Sharpness / Acutance (lens performance) (ISO 12233 [8])
- Optical aberrations like distortion (ISO 17850 [9]),
- chromatic displacement (ISO 19084 [10]),
- shading (ISO 17957 [11]), flare (ISO 18844 [12]) etc.

And then for cameras in our phones specifically

- The reproduction of small randomly oriented and often times low contrast structures, publicly known as texture (ISO 19567 [13])
- Color shading (ISO 17957 [11])
Which camera should you use?

Apple’s native camera
- Jpeg or HEIC – no raw format
- Manual controls: AE & AF lock and brightness
- Stores full-res file on device and uploads to iCloud
- Photos has very good controls over global image editing an image, however there are no localized control

Adobe Lightroom app
- DNG or Jpeg
- Manual controls: EV, Time (1/10,000 – 1 second, with highlight gamut warning), ISO (32-2,500), WB (the usual ones, plus custom), exposure lock, focus indicator
- Once full-res file is uploaded to CC, only a smart preview is saved on device
- Has all global image editing features that Lightroom Classic has to offer
- Localized control: brush, linear and radial gradients, healing brush and more
- Biggest plus - is that we can import a custom camera profile for use in the phone app
Which camera should you use?

Screen captures with original images zoomed in 100% - sunny day, low ISO.
Which camera should you use?

One website states:
Which camera should you use?

Summary at this point

- Due to Apple’s lack of manual control for exposure, artifacts and lack of refined detail of the capture, I will continue this presentation on the results found in the Adobe Lightroom’s camera app. In my opinion, the poor image quality from Apple’s camera may be created from the aggressive automatic compression algorithms and noise reduction even if the ISO is low.

- Plus, there is no way to apply a profile in a mobile devise using the Apple’s native camera. One would have to assign it or convert it in Photoshop. And remember that the sensor data has already been “converted” to Display P3, because that is what happens regardless of format - jpeg or HEIC.

- The Apple camera would NOT pass the dead leaves target test
Possible Workflow

To find out if we can achieve more accurate color from an iPhone, there are still several steps to complete first.

- We have just completed the first step, camera selection
- Light the target
- Capture the target
- Get captures into Photoshop or Lightroom
- Selecting the correct exposure of the target
- Software for sensor characterization
- Photograph an piece of art work
- Apply profile in ACR, Lightroom Classic, Lightroom or Lightroom for mobile
- Review image on profiled monitor with painting under correct viewing light
- Make a print
- Review and decide if additional editing is required
How create a custom sensor profile
First, photograph the target
How to photograph the target

- First, set-up target as seen
- Camera is set on a tripod and you have cleaned the lens
- Place target in camera finder in approximately the center. This uses the "best" part of the lens/sensor without edge distortions effecting the target.
- I used the grid to align the camera to the center of the target
- The bottom illustration is how Lightroom’s custom WB tool allows you to select a neutral for custom WB
How to photograph the target

- Completely even lighting across the entire target
- Exposure is critical
  - The four white corners need to be L = 96
  - The black patches should be around L = 8
- Began with an Auto meter reading of the neutral gray target
- Then, went to manually controlling Sec or time of exposure in Professional capture mode
- Bracketed exposures in 1/3 stop increments
With the correct exposure determined

I will address how I got to this stage in the Case Study. In ACR, I can set four Color Sampler points for both white and black patches, as seen near the top of the window. The four white patches: 245-250 or L=96. So, this is THE file that I to use to create the profile.
How did I get the files into Photoshop?

Lightroom for mobile will upload images to the Creative Cloud. This can be monitored by touching the cloud icon in upper right.

Lightroom (web) will allow all images to be displayed and edited. Adobe will Sync with my phone and Back Up all images into the Creative Cloud. The full rez images will be stored in the CC and only smart previews will be left on my phone, which takes much less space on the phone.
How did I get the files into Photoshop?

Once I launch Lightroom Classic (desktop version), the Creative Cloud will synchronize between the two versions.

I have set my preferences to place the synchronized files onto an external hard drive.
How did I get the files into Photoshop?

In Lightroom Classic (desktop version) I can right click on the image and Edit In > Photoshop. Or, I could click on Show In Finder and open it in Photoshop directly.

As an added bonus, I could create a Collection in Classic, click on the synchronize button and the collection will appear in Lightroom web and for mobile.
Which profiling software should you use?

**basICColor Input 6**
- Input file formats: dng, tiff or jpeg
- Stand alone only at this time
- Many user controls
- Profile can be edited prior to generation
- Profiles for both .dcp and .icc
- Generates a report on deltaE00 on all patches
- Can use two targets, i.e. SG Digital and the Munsel Gray Scale = possibly higher color accuracy
- User can select the type of profile: cultural heritage, photography, black & white, etc

**X-Rite, ColorChecker Camera Calibration**
- Input file formats: dng or tiff
- Plug-in to PS and LR
- Stand alone
- No user controls or presets
- No editing capabilities within software
- Profiles for both .dcp and .icc
- Provides no verification report
- Only one target can be utilized for profile generation
- Creates a very “punched up” look – high saturation and high contrast
basICColor Input 6

- For dcp, Capture One icc and icc – has multiple or user made presets
- One can edit color or neutrals prior to profile creation within Input 6
Lot’s of different Presets to match your needs

You can create custom presets as well
basICColor Input 6

You are able to use two targets to increase accuracy

You are able to edit colors and/or neutrals
X-Rite, ColorChecker Camera Calibration

- For dcp – plug-in does not accept SG Digital target, only the ColorChecker or PassPort
- Stand alone - a work around for the SG Digital target by placing green corners around ColorChecker patches
- No user settings other than alignment of patch indicators
How to apply a dcp profile in Lightroom for mobile

In Lightroom for mobile app, click on the Profile tab and you will see “Profiles” and that is where you are able to select your custom user sensor profile. Note: Lightroom considers each lens a distinct camera. If an image was taken with the telephoto and you only made a profile from the wide, Profiles folder will not show up.

Note: if you have a multiple camera/lens phone like the iPhone 11 Pro Max, the resulting profile is for the camera you used to capture the target, i.e. telephoto, wide, ultra wide. So, a profile for each camera will have to generated in order to produce a higher color accurate image.
How does the profile get to Lightroom mobile?

Launch Lightroom (the web version)

- Go to the pull down menu, File > Import Profiles & Presets, select your newly created profile/s that are fairly deep in your system, and then click on Import.
- Once completed, give the Creative Cloud a little bit of time to synchronize and it will show up on Lightroom for mobile
- **NOTE:** if you have multiple cameras/lens on your smart device, you will have to create separate profiles for each. The profile is camera+lens specific and it will not be available for any other camera+lens image capture. Example, iPhone 11 Pro Max has three lenses, so Lightroom wants three different profiles, one for each lens.

Where is the actual profile stored?
Mac – in Finder > pull down menus Go > hold down Option key > Library > Application Support > Adobe > Camera Raw > CameraProfiles > the new profile
How do the two profiles compare?

It is a little difficult to see the differences here, so let’s take a better look via Lightroom comparing the two profiles.

Note: Gamut Volume in ICC’s Input 6: 2,650,850
X-Rite: 3,000,940
An ICC camera profile is for non-Adobe products – primarily, Capture One

For both basICColor Input 6 and X-Rite, ColorChecker Camera Calibration

- Open raw file from ACR or LR
- Use ProPhoto as the color space and make no other image changes, except WB
- Save As … tiff
- X-Rite software, click on ICC_TIFF
- Input 6, select preset
- Drag-n-drop tiff into window
- Relocate corners if necessary
- Click on Create Profile
- Done
How to view an image on a profiled phone screen

ColorTRUE is an app for the phone by X-Rite. You are able to profile your screen and view an image in the Gallery section of the app. It will show what the image looks like in profiled space.
Photoshop ACR Settings

- Workflow option inside ACR.
- ProPhoto RGB, 16-bit, do not resize, 300 dpi for Canon or 360 for Epson, Gray: gamma 1.8
- Check all Ask When Opening
Lightroom Settings

Color settings in Lightroom:
Lightroom > Preferences > External Editing
Case study – MWG Studio

Can the iPhone photograph a painting and produce a print that has near accurate color when compared to the original?

This is the artist’s set-up to photograph her art work in her studio with her iPhone for reference information and for web placement.
Case study – MWG Studio

I photographed the CCSG card in her studio using her lighting system. The lighting was fairly even and in this exposure the numbers in the white and black patches are correct. I repeated the steps addressed in slide 11 on meter reading, manual settings and neutral balance.
How to select the correct exposure

Open all bracketed images in Photoshop’s ACR. Then place eye dropper’s on 4 white and 4 black patches. The “correct” exposure can be very easily and quickly located by scrolling through the selected files.
Case study – MWG Studio

Using the iPhone 11 Pro Max - in ColorThink Pro I opened the icc profile from Input 6 Pro software and the Gamut Volume is 2,713,110: Whitepoint L 100 and Maximum Black L 0.
Case study – MWG Studio

Using the iPhone 11 Pro Max - in ColorThink Pro I opened the icc profile from X-Rite software and the Gamut Volume is 3,000,940: Whitepoint L 100 and Maximum Black L 1.
Case study – MWG Studio

- I began to photograph the painting and set Lightroom camera to indicate where I’m sharply focused and highlight gamut warning, which looks like this.
- Green lines – sharp focus
- Black lines – highlight gamut warning
- Now I can shorten exposure time to ensure that the highlights are not clipped
Case study – MWG Studio

Lightroom’s camera – with custom profile

Apple’s native camera – no custom profile
At this stage, I have four profiles for the iPhone 11 Pro Max. There are two from MWG Studio, one from basICColor and one from X-Rite. Visually, the basICColor profile is more accurate. The file is slightly dark from original exposure, but color seems close to painting. The other two profiles are for sun light conditions.
Still in Lightroom and I’ve captured an image and applied the custom profile.

Before moving on, I review in ColorTrue for initial accuracy

Looks good here. Time to move onto the desktop computer and monitor
Monitor accuracy is critical for evaluating color, etc in your image

- Image color, brightness, contrast, etc cannot be evaluated without this step Monitor calibration
- Monitor characterization – basICColor Display 6 or X-Rite i1 Profiler? Another topic for another day.
- Monitor hood

- Viewing environment – wall color, brightness, etc
- Have a desktop viewing booth next to, but not spilling light onto your monitor
- Printer+paper+media settings that created the profile which are completely repeatable each time you make a print
Case study – MWG Studio

Major issue, is YOUR ability to recognize color accurately on monitor and in print!

- The ability to recognize color accurately is not innate in our human nature – it is a learned or trained skill

How to learn?

- I highly recommend taking a class on how to print from color negatives at a local community college.
- Question the color in an inkjet output.
  - Is the skin tone true
  - Are neutral areas neutral
- Use color viewing filters
- Other techniques to see color
Case study – MWG Studio
Color Management

Okay, you got the capture, you’ve imported and applied the camera profile in Lightroom. Now what?
- The general workflow …
  - Edit the image in Lightroom as needed
  - Edit In …. Photoshop, as needed
What are the workflow steps I took for print matching – if possible?

- I first printed a test image from the original file after evaluation between calibrated monitor to painting in my viewing booth
- I made adjustments based on this comparison in Lightroom
- Placed output next to painting in viewing booth for analysis

- Made additional global adjustments in Lightroom, and then handed off to Photoshop.
- In Photoshop I made localized adjustments based on my analysis between output and original
- In Photoshop, I continued to make specific adjustments until output was as close as it could be to the original
Case study – MWG Studio

- This image illustrates how I approach each and every image as I work it prior to printing and how I teach students to approach their own work. I have about five questions that I teach and when I work with clients to get the final results desired by them – not my own.

- I have had this approach since 1981 when I begin an mentorship with a photographer who was considered to be a master printer at the time.

- There are many other variables, which we will not get into today.
Case study – MWG Studio

- When comparing inkjet output to original, realize the surface quality of each.
- Realize the textural differences.
- Realize that the inkjet is 2D and that the original could have 3D paint qualities that cannot be reproduced with diffused, flat lighting.
- Recognize that the original may have a higher reflectance value than the inkjet print/paper.
What about the print output from all of this work as compared to the painting?

I’ve brought the original painting and a couple of inkjet prints for our personal visual comparison and learning. Let’s take a look.

But why did I have to apply some Photoshop editing to the file?

• Pigments have their own reflective characteristics
• Maybe metamerism effects from artist’s copy lights to viewing booth, profile, CCSG????
• Some pigments just cannot be accurately reproduced, i.e. Cobolt Blue
• Lens quality and sensor size and sensor spectral sensitivity are huge factors
• Quality of image processors in the phone
• Ideally, the use of a target should be constructed with the same dyes/pigments as the object being photographed
• Still, camera profiles are to minimize, not necessarily to match exactly, the color differences between target references and measurements captured from that target
• Finally, to produce a more faithful representation of the original painting
As a result, which camera will I use personally?

Adobe seems to capture true sensor / pixel data. We see the detail and noise as it is recorded by the sensor. Lightroom’s camera is the only camera that I will use for my still photography work.

Apple seems to apply algorithms and noise reduction that may or may not be necessary, and it creates artifacts and it has no fine detail in the image. In my opinion, this is unacceptable, unless you will only be using images for social media or web placement. I will use Apple’s camera for motion captures, but not for stills.
What to do with what you’ve learned

Cameras in mobile devices can have improved color accuracy
But, it does take time and precision work to capture and process a target correctly

- The targets and software mentioned today
  - basICColor Input 6 or Input 6 Pro – $625, $800
  - PassPort, ColorChecker or ColorChecker SG - $119, $80, $369
  - X-Rite, ColorChecker Camera Calibration v2.0 – free
    https://www.xrite.com/service-support/downloads/c/colorchecker_camera_calibration_v2_0
What to do with what you’ve learned

Cameras in mobile devices can have better color accuracy

- But, who needs color accuracy from a mobile device?
  - Any science that conducts field research – archeology, biology, art students and instructors, etc
  - Possibly professional photographers: infant, portrait, fashion, high-end product, designers (fashion, interiors), textile manufacturers
  - A professional photographer or an artist producing a copy file of art work for website and/or reproduction
  - You are just a geek about color regardless of capture device
  - Frans Lanting – www.lanting.com
What to do with what you’ve learned

Cameras in mobile devices can have better color accuracy

- But, who does not need color accuracy from a mobile device?
  - Anyone who is mostly interested in the quickie selfie
  - Family snapshots and other memento type pictures
  - If you are a serious or avid mobile photographer, who tweaks the color for interpretation and/or personal voice
  - If you just don’t care and/or never look very closely at the color
What to do with what you’ve learned

The cameras in smart devices can create more accurate color – Conclusion

- With work, time and money, color accuracy with mobile device cameras can be greatly improved to the point of print matching, fairly closely, to the original painting.
## What to do with what you’ve learned – Possible workflow

<table>
<thead>
<tr>
<th>Lightroom</th>
<th>Lightroom</th>
<th>Photoshop</th>
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<tbody>
<tr>
<td><strong>Library Module</strong></td>
<td><strong>Lightroom</strong></td>
<td><strong>Possible Photographic Workflow</strong></td>
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<tr>
<td><strong>Develop Module</strong></td>
<td><strong>Develop Module</strong></td>
<td><strong>Photoshop</strong></td>
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<tr>
<td>Shoot raw format</td>
<td>Calibrate computer’s display as needed</td>
<td>If you are in LR &gt; Edit In &gt; Photoshop, make sure preferences are set to ProPhoto at 16-bit, before exporting into Photoshop. In Photoshop, Edit &gt; Color Settings, Working Spaces, set RGB to ProPhoto: Conversion Options: Engine, Adobe: Intent, Relative Colorimetric, check Use Black Point Comp, Use Dither and Compensate for Scene…. If you are working in ACR, set ProPhoto adn 16-bit in Workflow Options.</td>
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<td>Include Passport, if needed.</td>
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<td><strong>Copy onto hard drive from media</strong></td>
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<tr>
<td>Do you use Lightroom Classic CC or Lightroom CC? Or both? Lightroom Mobile?</td>
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<td><strong>Import into Lightroom or Synchronize</strong></td>
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<tr>
<td>• Add without moving</td>
<td>• Crop/straighten</td>
<td>• Additional retouching</td>
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<tr>
<td>• Apply import preset with IPTC contact, creator, ©, © statement</td>
<td>* If needed: Photomerge (HDR/Panoramic)</td>
<td>• Compositing / layer masking</td>
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<tr>
<td>• Umbrella key words?</td>
<td>• Adjust image density: white/black point, others as required</td>
<td>• Smart Objects</td>
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<tr>
<td></td>
<td>• White balance (on Passport if included)</td>
<td>• SOE layers as needed*</td>
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<tr>
<td><strong>Review</strong></td>
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<tr>
<td>• Loupe/compare/survey. Check sharpness @1:1</td>
<td>• Color/tone via HSL via TATool</td>
<td>• Filters / smart or not</td>
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<tr>
<td>• Rate/label/flag</td>
<td>• Lens correction / CA, if not applied on import</td>
<td>• Precise localized tonal/color control</td>
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<tr>
<td>• Remove/delete &quot;bad&quot; files</td>
<td>• Retouch / clean-up: heal / clone</td>
<td>• Gray overlay/soft light layers</td>
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<tr>
<td>• Add image specific key wording</td>
<td>• As needed: noise reduction / transform / debake / etc.</td>
<td>• Treatments: Photomerge, Layer blends, transformations, content aware issues, type &amp;</td>
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<tr>
<td>• Add image specific metadata (captions, titles, etc.)</td>
<td>• Localized control with gradient / brush</td>
<td>• Print to check work, but first add a sharpening layer for printing</td>
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What to do with what you’ve learned – Additional Apps

Photography Apps For Your Consideration

Note: Fred has his phone are designated with (P)

This list is far, far from being complete. Search the App Store and Google Play Store to find unique apps that can express your personality and style of imagery and image creation. My recommendation is to find apps that do not change the size of the original or that cannot save a copy with the changes and maintain the original image.

Generally speaking, there are over 3.5 million Android apps and over 2.3 million for iOS.

Any time you download a new app, ALWAYS check the settings in the app and then in the phone’s settings as well. You’ll want to make sure you are getting the highest quality you can from your phone and app.

Google Photos (free) — if you do not have any cloud-based storage for your phone imagery, then please at least download Google Photos or Google Drive. Trust me, you do not want to lose years of photos if you loose your phone or if it is completely dies on you. It will hurt – much.

If you are looking to get more from this smartphone photography class, consider downloading and it is free.

* Snapseed by Google is [free] — I use this app a lot as well. It does things that LR cannot do and it does not downsize the file. It can create textures and grain, glamorous glow, dream, grunge, Noir and much more.

Additional Camera app.s

Lightroom CC pro. — This is a major one for me, I use the camera inside LR, because it captures a raw (DNG) file. This allows for LR to use all of the sensor data without it being compressed into a jpeg file, like your in-phone camera does. I also shoot a lot of HDR captures, which produces a 16-bit DNG file when opened in Photoshop. This is a huge file from a 13mp phone camera. It also automatically uploads, stores and removes from your camera’s hard drive, to the Creative Cloud. You have total access to your original files from your phone, tablet or desktop computer, even without internet connection.

Slow Shutter Cam — lets you capture a variety of amazing slow shutter speed effects

645 Pro app — full manual, AV, TV exposure modes; choice of metering modes; manual focus override; camera raw; film looks and more.

ProCamera
Extra’s - what to do with what you’ve learned

Editing on mobile devices
- Use a stylus, not your finger to edit
- Create a workflow for your logical thinking process
- Additional apps – email me and I will send you a short list of apps that I have and use. Please state “apps” in the subject field of your email.

Accessories to enhance photographer’s aspirations
- Lenses
- Grips
- Lighting
- Additional accessories – email me and I will send you a list with links for some of the equipment that I use, have shown and/or recommend. Please state “accessories” in the subject field of your email.
What to do with what you’ve learned – Accessories

Care Touch Lens Cleaning Wipes, Pre Moistened Cleansing Cloths Great for Eyeglasses, Tablets, Camera Lenses, Screens, Keyboards and Other Delicate Surfaces - 210 Individually Wrapped Wipes

- $14.99
- HIGH TECH FORMULA - This high tech ammonia-free formula, cleans effectively without leaving streaks or residue
- INDIVIDUALLY WRAPPED - Each cleansing wipe is individually wrapped to keep it fresh and moist for best results
- STREAK FREE - You can safely clean your glass surfaces, screens, tablets or lenses without worrying about it getting scratched
- CONVENIENT - Keep several of these individually wrapped lens wipes in your camera pack, purse, at home, at work or in your car
- CLEANS DIRT AND BACTERIA - The pre-moistened wipe will remove the bacteria, dust, germs and dirt from your phone, glasses, screens, or other surfaces

https://www.amazon.com/Care-Touch-Moistened-Cleansing-Eyeglasses/dp/B07DS0CY7V/ref=sr_1_1_sspa?ie=UTF8&qid=1533845958&sr=8-1-
spreadingkeywords=overall%3Anear%3Acare%3ALens%3ACleaning%3ASupplies%3A1

Moment Lenses & Case (F)

The high-end, third-party lens manufacturer, Moment, appears to have won the race to bring out case and lens kits for the iPhone X. They offer a wide angle, a 2X telephoto, a fish-eye, and a macro lens. Since the iPhone X has an excellent optical 2X telephoto lens and a regular wide-angle lens you may want to look at the Macro Lens. If you do decide to go for Moment’s 2X Telephoto lens then you’ll be pleased to know that when placed in front of the iPhone X’s built-in 2X telephoto lens you’ll get the equivalent of 4x telephoto "zoom".

However, it’s worth noting that with any of Moment’s lenses attached you won’t be able to use the Portrait Mode feature since the bulk of the Moment lens blocks out the second lens, meaning the iPhone’s camera can’t gather the depth information it needs from the scene.

Moment’s case and lenses are available for the iPhone X, iPhone 8 and iPhone 8 Plus.
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Thank you for attending!

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Photographic Services to Education and Industry