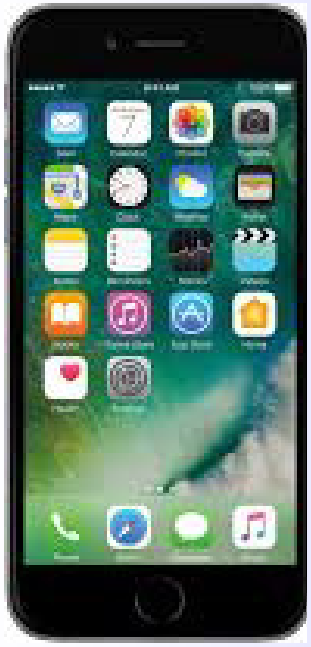

Phone vs Camera

Using your phone for 3D

By George Themelis
Detroit - May 2022

Stereogram (NOV 2017)

Smartphone 3D (Does Size Matter?)

A Tutorial Article by George Themelis

Late To the Party

I recently started shooting sequential 3D pictures with my iPhone 6. To say that I am pleased is an understatement. I am having a blast!

Yes, I know, I am late to the party. I have had this phone for nearly 3 years now and that's the first time I used it for 3D. Some people have been doing it for 10 years or more. The reason I am late is that I never considered the smartphone camera to be good enough, and always used a regular camera. But smartphone cameras have been improving and the results (seen all over Facebook in 2D) are impressive.

Consider these numbers [1]: 98.4% of all consumer cameras sold in 2016 were built into smartphones and 92% of smartphone users worldwide say that the camera is the most used feature on their phones. So, the smartphone camera is a force to be reckoned with.

Size Matters—Or Not?

In addition to the iPhone, I have been experimenting with compact cameras too. What smartphone cameras and compact cameras have in common is a **small sensor**.

The Table here summarizes sensor sizes for typical cameras. The sensor name is based on an old TV tube convention and it is not the actual size of the sensor. For example, the 1" sensor, which is becoming popular among high end compact cameras, is not 25mm but only 13.2x8.8mm (the diagonal is 15.9mm or 0.62"). The crop factor is the ratio of the full frame (36x24mm) sensor diagonal (43.3mm) over the sensor in question. This is often used to convert actual focal lengths to "full frame equivalent." For example, for the 1" sensor, the crop factor is 43.3/15.9 = 2.7x so a lens of 10mm focal length on a 1" sensor camera sees the same field of view as a 27mm lens on a full frame camera.

The Table also shows typical types of cameras that use these sensors. There is a tendency towards larger sensors, so newer smartphones have slightly larger sensors and some upscale compact cameras have sensors as large as APS-C size.

How does the size of the sensor affect the quality of the pictures? I like to think of the sensor as the film. We know that larger film means better quality. Small films (View-Master, for example) need to be magnified more, causing grain to show. Same with digital photography. A larger sensor collects more light and has less noise (the equivalent of film grain). Here is a list of large sensor advantages:

Sensor Name	~Size, mm	Crop Factor	Typical Cameras
1/3.91 inch	4.6mm	9.4x	Sony 3D video
1/3.2 inch	4.5x3.4	7.6x	Smartphone
1/2.3 inch	6.2x4.6	5.6x	Typical compact
1"	13.2x8.8	2.7x	Upscale compact
Micro 4/3	17.3x13	2x	Mirrorless
APS-C	23.5x15.6	1.5x	Mirrorless & DSLR
Full Frame	36x24	1x	DSLR

1. Higher resolution
2. Improved low-light performance
3. Increased dynamic range
4. Background blur / subject isolation

So, unquestionably, larger sensors give better quality pictures. **But at what expense?** At the expense of size and weight. Larger sensors mean larger and more expensive cameras. It also means larger and more expensive lenses. As they say, the best camera is the one that you carry and use. If you do not carry a camera because it is large and complicated, then it is not a good camera for you.

Do We Need Better Quality?

That's a good question. **For the stereo photographer, in most cases the answer is "No."** Here is why:

1. A larger sensor has advantages when showing pictures as large prints. Most stereo photographers see their 3d pictures in various 3d monitors/TVs, stereo projection, and 3" stereo prints. These viewing conditions do not require high resolution. This was demonstrated recently by Jay Horowitz in our club.

2. The type of photography is also a factor. Certain types of photography, like landscapes, low-light, and long exposures, will benefit from a large sensor. I have not been able to take distant nature shots with digital cameras that look as good as pictures from my RBT S1 film camera. Sequential 3D favors certain type of pictures like buildings, shots from high-rise buildings or airplanes, and close-ups. Some of these pictures, like close-ups/macros (a favorite now of many stereo photographers) are the least demanding in terms of resolution.

3. Post processing can reduce the sensor size impact by making even lower quality pictures look good.

4. Other factors, like composition and subject matter, have more weight than image quality.

So, from the list of large sensor advantages (#1-4) above, **if resolution and image quality are not an issue, most of the large sensor advantages disappear.** As an example, I have received PSA awards from 3D still frames grabbed out of a TD20 Sony 3D Video camera. The sensor in this camera is smaller than cell phone sensors (see Table) and the resolution is only 1MP (1920x540 to be exact).

The background blur/subject isolation (#4) is an interesting one. Stereo photography normally requires everything to be in focus. In previous Tutorials on lenses we discussed some of the advantages of throwing the background out of focus. This helps with portraits and bird/wildlife photos. In this case, it

(Continued on page 5)

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helps to have a large sensor, together with long focal length lenses and wide apertures. But, for everything else, usually it is better to have everything in focus. So, **small sensors, with their large depth of field, actually have an advantage over large sensors for 3D.**

iPhone 3D History

Curious about the history of iPhone 3D, I did a bit of "internet research." The first mobile phone was introduced in 1973. The first smartphone was introduced in 1992 (even though the word "smartphone" was not used until 1995). The first iPhone went on sale on June 29th, 2007. So, clearly, Apple did not market the first smartphone but it sure helped popularize it.

Stereo photographer extraordinaire, **Robert Bloomberg**, has been taking 3D iPhone pictures for a long time. He might even be the first person to take a 3D picture with an iPhone. He wrote: *"We [with wife Marilyn] got our first generation iPhones the first weekend they were sold to the public. We were visiting friends in Lake Tahoe and shot both the world's first iPhone cha-cha and also a side by side (using two iPhones)."* **Fig. 1** shows two of his first iPhone cha-cha shots.

Smartphone 3D Advantages

Smartphone photography has several advantages. The smartphone:

1. Is always available—fits in the pocket
2. Does not attract attention
3. Takes good pictures
4. Has a large display
5. Can be used with apps

#1 and 2 are very important for me. Often my iPhone is the only camera I have with me, especially when I am out running. I have taken pictures in private places with a stereo camera only to be questioned and told that photography is not allowed. I am being targeted because my equipment (often twin cameras on a bar, with cables hanging around) look strange and obvious. No one is bothering people who take smartphone pictures. So, **if I want to take pictures unnoticed, this is the way to go**.

#3 is interesting. How can smartphone cameras take good pictures with their small sensors and small plastic lenses? I found an article that explains it [2]. The title of the article is: *"Your Smartphone Camera Should Suck, Here is Why it Doesn't."* Here is the summary: Because of their physical limitations, smartphones will always be restricted in terms of sensor size and optics, but improvements in both image sensors and image signal processing make up for these limitations.

#4 is also interesting. My iPhone screen is larger and I can see the image better than any of my cameras. And the tendency is for larger phones, while cameras tend to get smaller.

#5 is an important advantage of smartphones. We are basically using a camera attached to a computer. There are numerous 2D apps that can be used to control the photo-taking process and improve the pictures. There are also 3D apps that aid the 3D recording process. One of them is 3DSteroid.

3DSteroid / i3DSteroid App

Our very own, **Matsui Suto** (creator of StereoPhoto Maker, SPM) has an app for taking 3D pictures with a smartphone. The app dates from 2011 and it is called 3DSteroid for Android or i3DSteroid for iPhones [3].

With this app the smartphone becomes similar to the Fuji 3D camera in "Advanced 3D Mode." After you take the first picture, you see an outline (ghost image) of this picture, which helps with the alignment of the second picture. After you take the 2nd picture, you can see the stereo pair on the screen (freeviewing might be required, but other options, anaglyph for example, are also

(Continued on page 6)

***Fig. 1 (Left)**: Some of the world's first iPhone cha-cha shots by Robert Bloomberg. Top: At Lake Tahoe, only a few days after he had his first iPhone. Bottom: First iPhone 3D to be accepted in a PSA exhibition. Bob writes: "'Peppers" was taken at the Marin Farmer's Market in July 2008. I'm sure there are others that may even have done better in competition, but it will take a bit of hunting on my part as I didn't always record the camera(s) I used."*

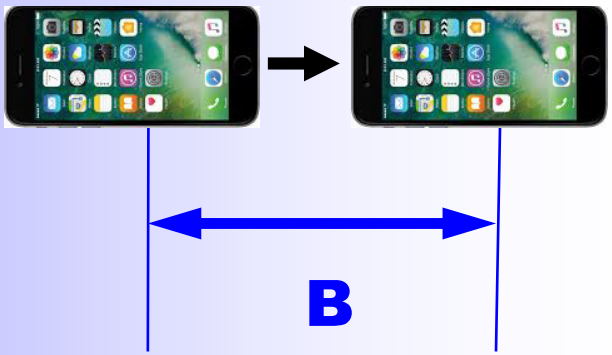
***Fig. 2**: i3DStereoid screen after I recorded a stereo pair. Clicking at the camera icon (top right) allows me to take another stereo pair. Clicking at the book icon (top left) brings up the menu.*

2017 → 2022 ?

- **Upgraded phone** (iPhone7 → iPhone13)
- **Upgraded 3D Camera** (Full Frame Sony RX1)
- Went on vacation (Utah in February) where **these two were my only 3D cameras**
- Have been actively **comparing the two**
- I would like to **share** my **experiences** with you

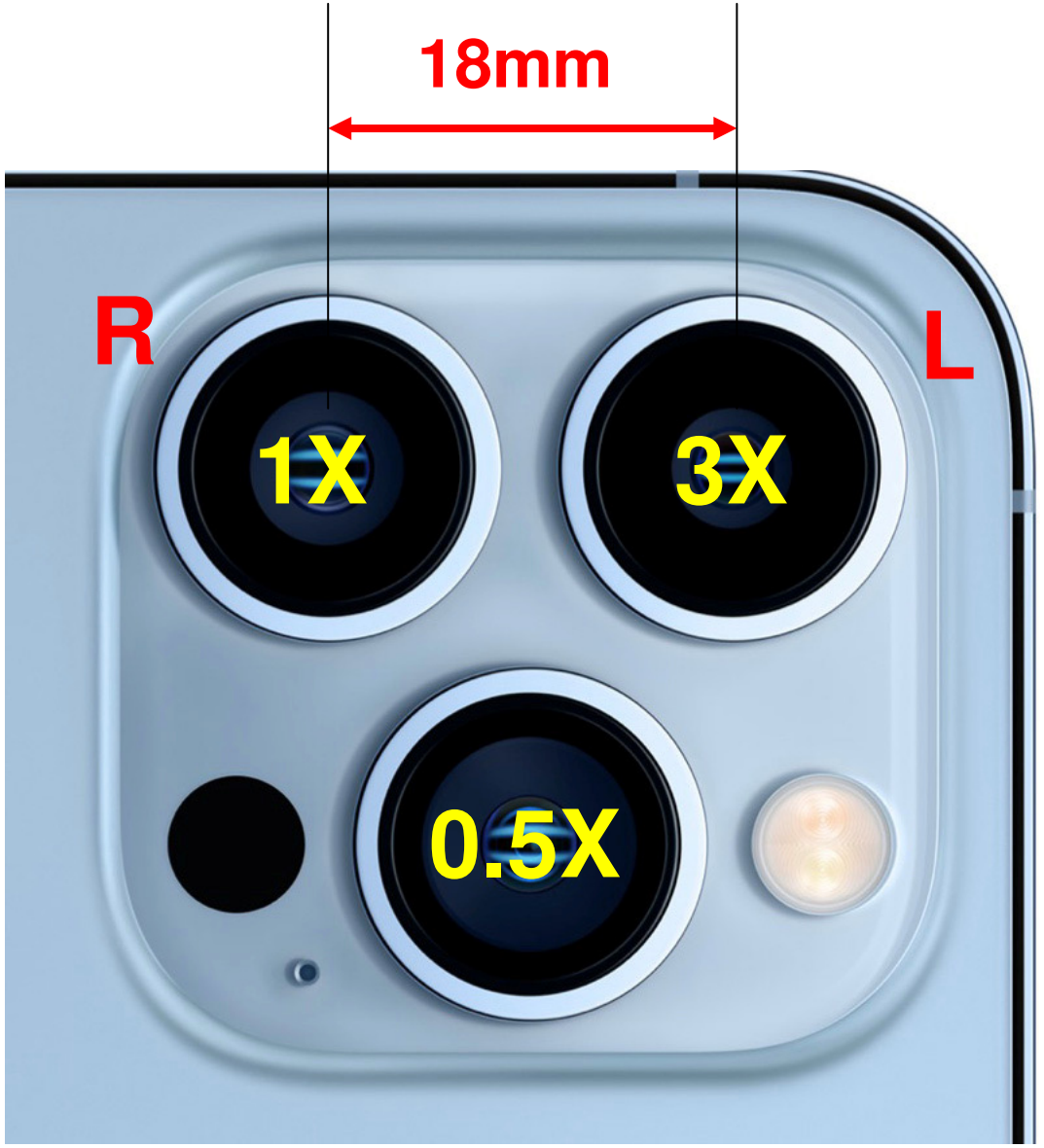
Different Types of Phone 3D

- 3D phone
- Twin phones
- Use two built-in Phone Lenses
- Use a beam splitter
- Use depth information that the phone records
- Use sequential (“cha-cha”) shots

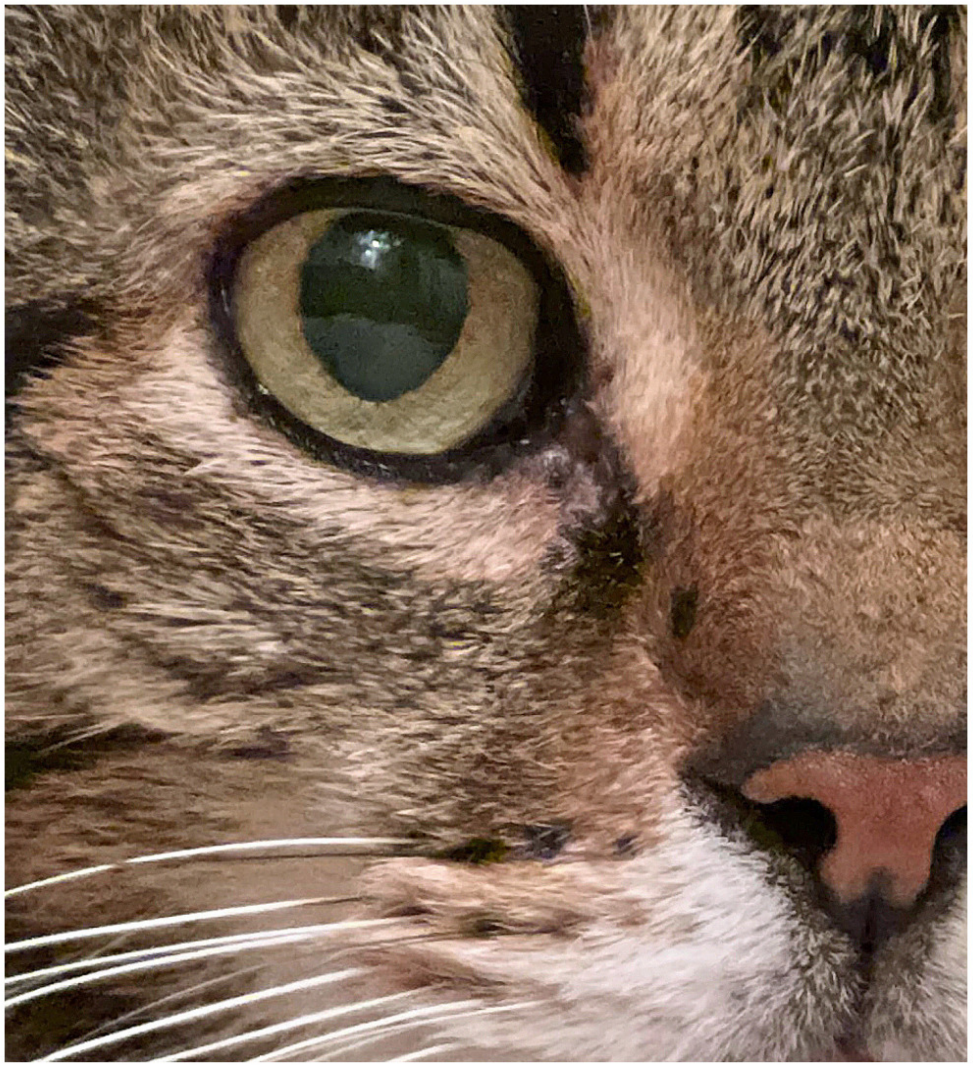


iPhone 13 lenses

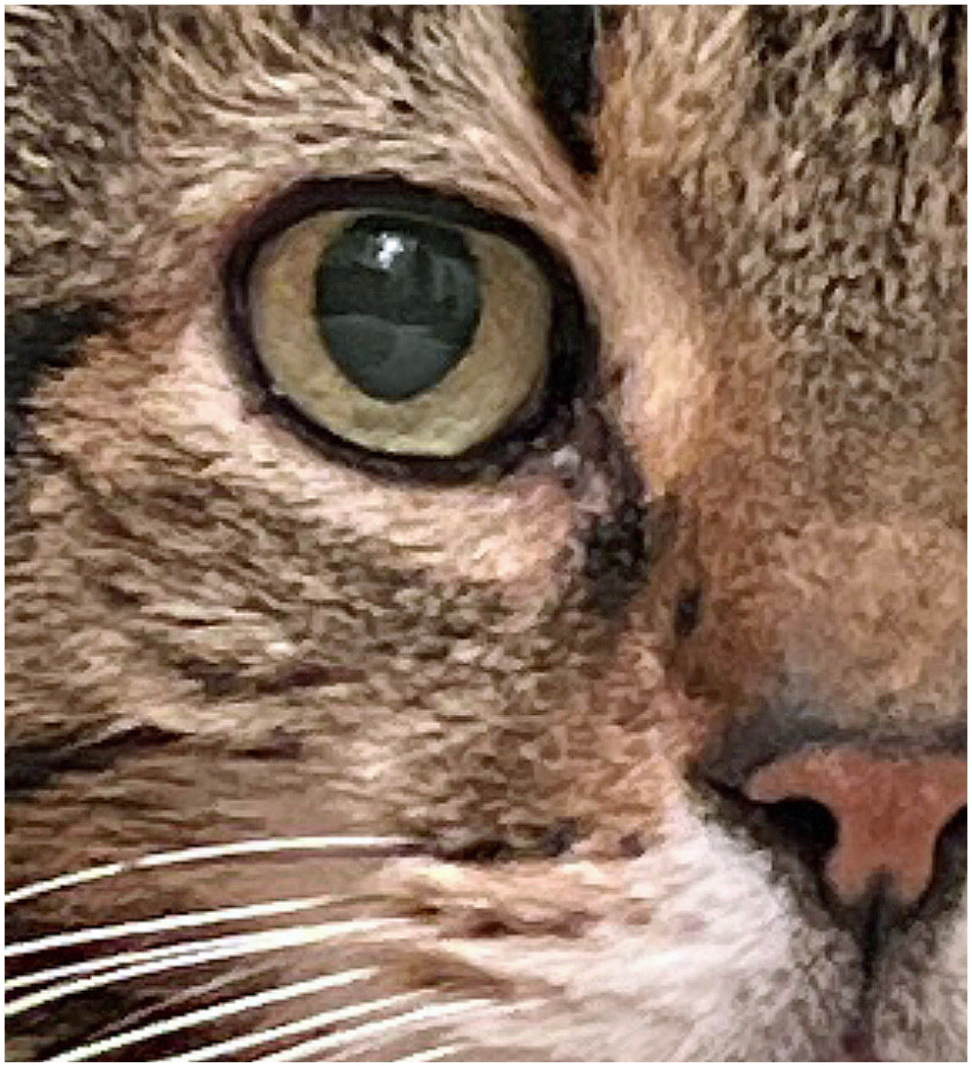
i3DPhotoCam



3X



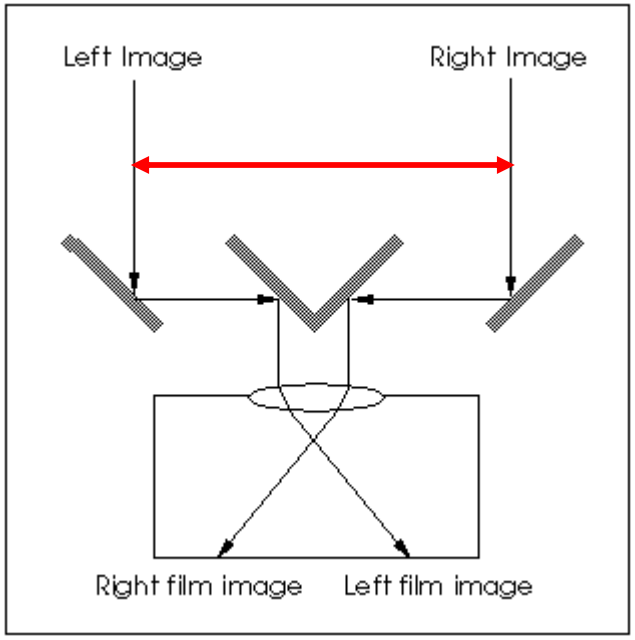
1X



Beamsplitters

bebe
3D FOR SMARTPHONES

deeper
3D FOR SLR CAMERAS



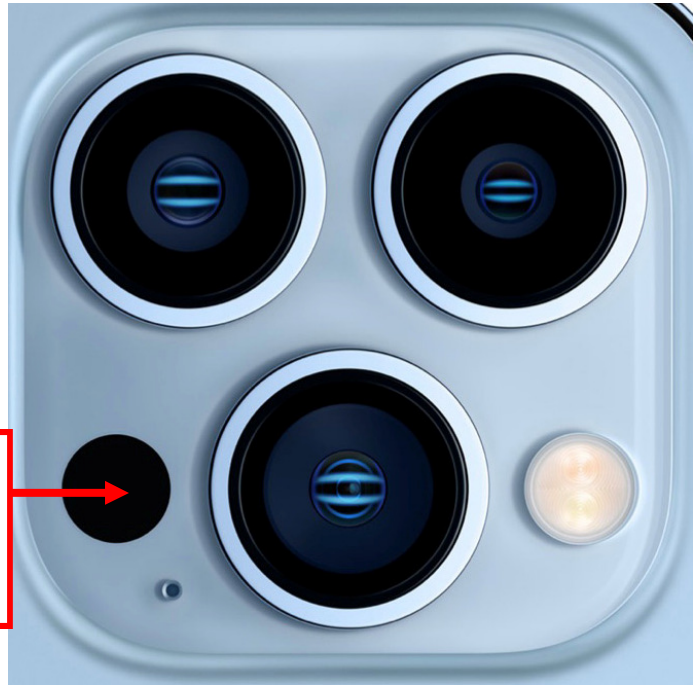
iPhone Portrait Mode

What Is Portrait Mode?

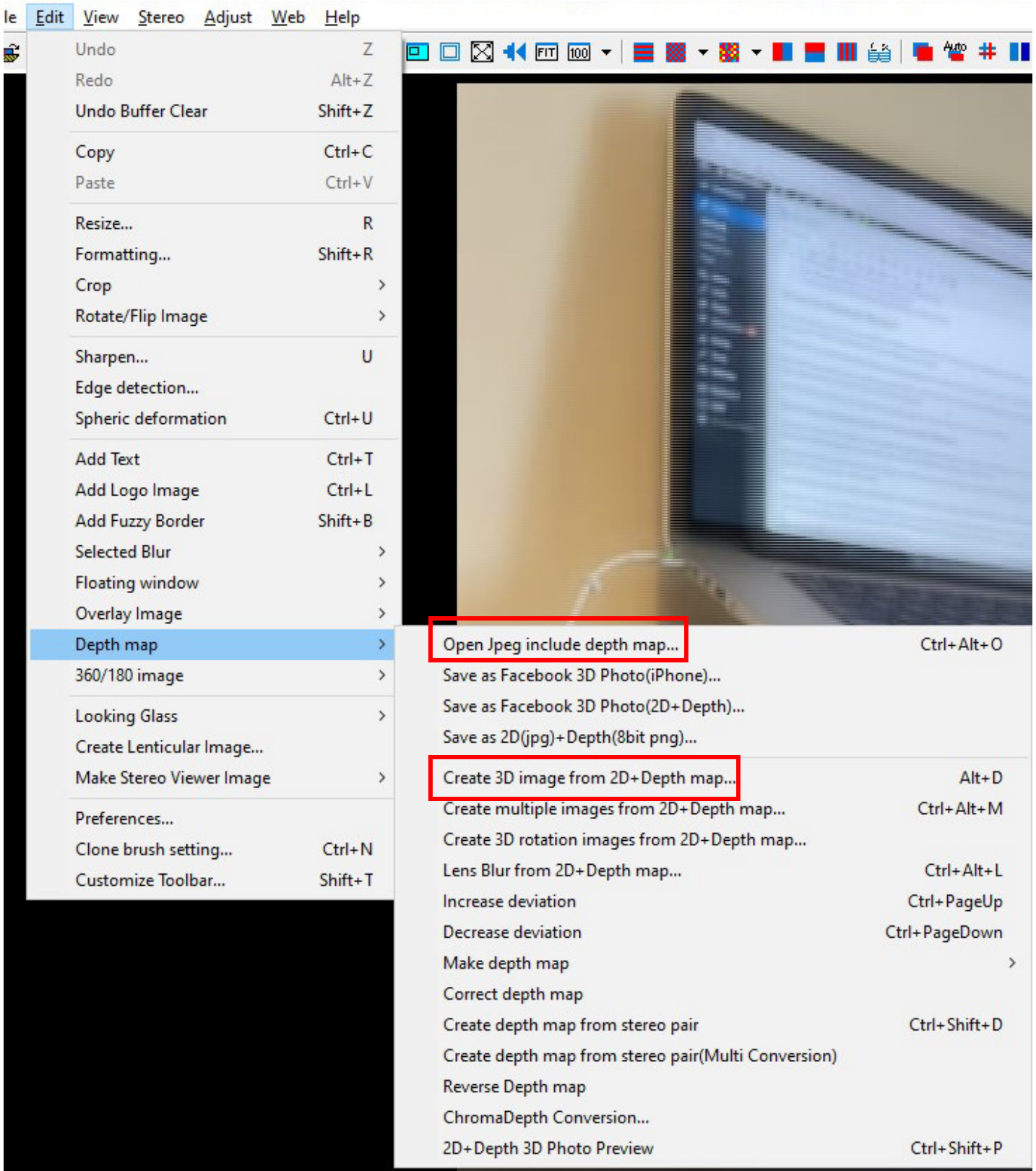
Portrait mode on the iPhone creates a depth-of-field effect that **blurs the background** of your photo while keeping the subject in sharp focus.

How Does Portrait Mode Work on the iPhone?

The iPhone uses **software algorithms** to fabricate a depth-of-field effect. This is in contrast to professional DSLR cameras which naturally create the same effect through the aperture of the lens.



Depth Maps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Edit
View
Stereo
Adjust
Web
Help
Undo Z
Redo Alt+Z
Undo Buffer Clear Shift+Z
Copy Ctrl+C
Paste Ctrl+V
Resize... R
Formatting... Shift+R
Crop
Rotate/Flip Image
Sharpen... U
Edge detection...
Spheric deformation Ctrl+U
Add Text Ctrl+T
Add Logo Image Ctrl+L
Add Fuzzy Border Shift+B
Selected Blur
Floating window
Overlay Image
Depth map
360/180 image
Looking Glass
Create Lenticular Image...
Make Stereo Viewer Image
Preferences...
Clone brush setting... Ctrl+N
Customize Toolbar... Shift+T
Open Jpeg include depth map... Ctrl+Alt+O
Save as Facebook 3D Photo(iPhone)...
Save as Facebook 3D Photo(2D+Depth)...
Save as 2D(jpg)+Depth(8bit png)...
Create 3D image from 2D+Depth map... Alt+D
Create multiple images from 2D+Depth map... Ctrl+Alt+M
Create 3D rotation images from 2D+Depth map...
Lens Blur from 2D+Depth map... Ctrl+Alt+L
Increase deviation Ctrl+PageUp
Decrease deviation Ctrl+PageDown
Make depth map
Correct depth map
Create depth map from stereo pair Ctrl+Shift+D
Create depth map from stereo pair(Multi Conversion)
Reverse Depth map
ChromaDepth Conversion...
2D+Depth 3D Photo Preview Ctrl+Shift+P

Original 2D

Depth Map

Different Types of Phone 3D

- 3D phone
- Twin phones
- Use two built-in Phone Lenses
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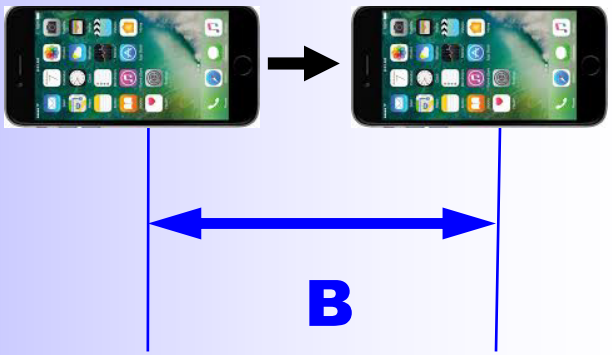
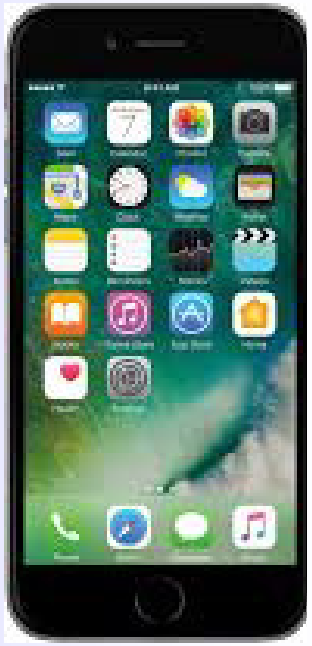
- Use depth information that the phone records
- Use sequential (“cha-cha”) shots



Phone 3D Advantages



- **Always with you**
- **Unobtrusive**
- **3D Apps**
  - Guides for alignment
  - Measures Deviation
  - Displays 3D
- **Flexible stereo base** (true for all cameras)
- **Small Lens** (has some advantages)
- **Continuous image quality improvements**

Phone 3D w/ Steroid App

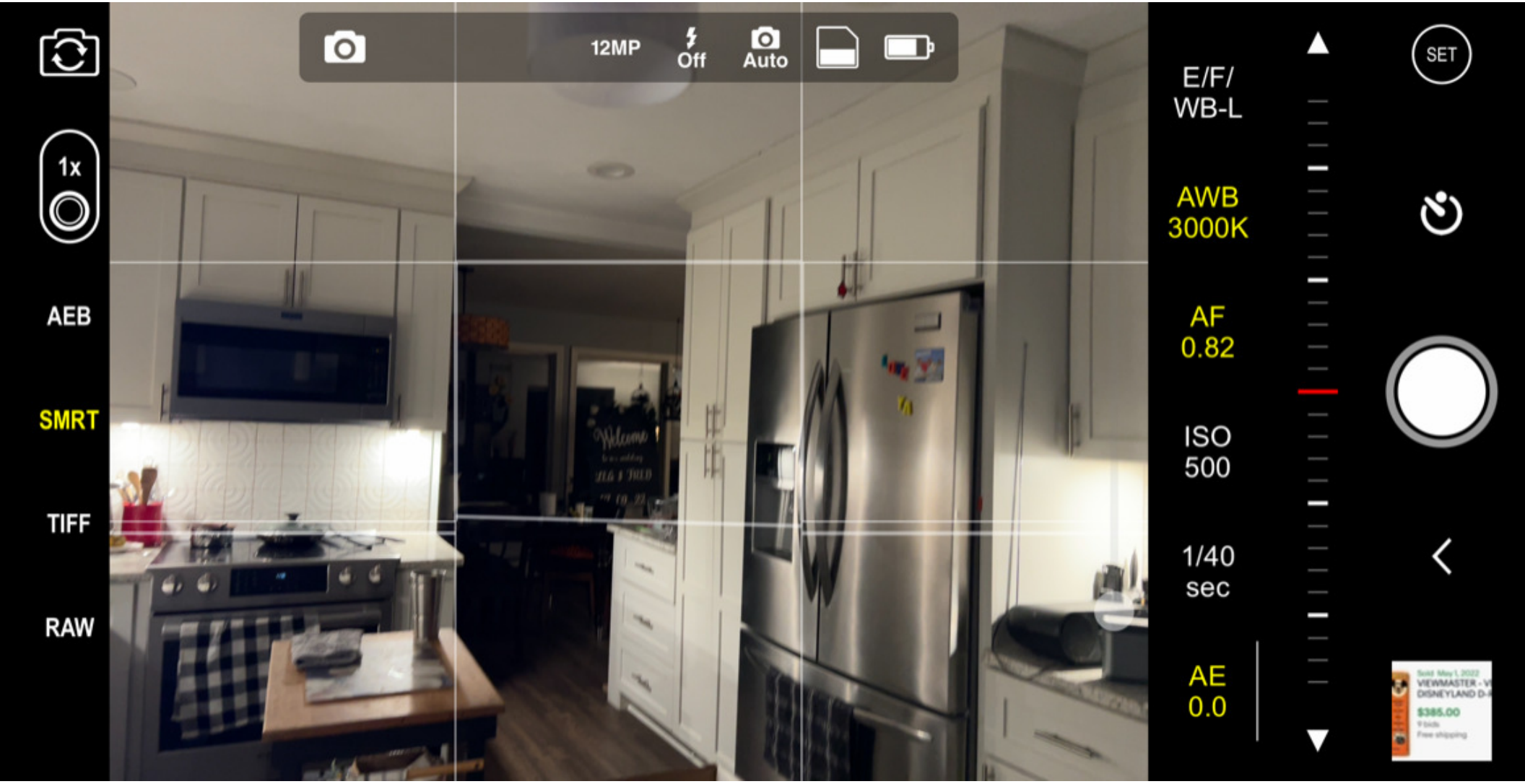
Matsui Suto (2011):
3DSteroid (Android)
i3DSteroid (iPhone)

- Smartphone becomes similar to the Fuji 3D camera in "Advanced 3D Mode"
  After you take the first picture, you see an outline (ghost image) of this picture which helps with the alignment of the second picture.

- **After you take the 2nd picture, you can see the stereo pair on the screen**
  (freeviewing might be required, but other options + viewers are also available)

- **You also see a value for the deviation**, which can alert you that something might be wrong (too much/little shift/depth)

Phone w/ PROCAM App



Phone 3D Limitations / Concerns

- **Stationary Subjects**
- **Flexible but advanced**
  - Alignment
  - Deviation
  - Post Processing
- **Cost**
  - New iPhone 13 (2022) = $1,300
  - Used iPhone 7 (2016) = $100
- **Lacks camera controls**
- **Image Quality**
  - Small Fixed Lens (no zoom)
  - Small Sensor
  - Cannot escape laws of Physics
  - Makes up with post processing

Limitation of Moving Objects

Moving objects are the biggest enemy of single camera stereos (small movements can be tolerated or perhaps corrected)

This still leaves a lot of subjects possible:

- **Buildings / Architectural Details**
- **High rise Cityscapes**
- **Landscapes / Nature (without wind)**
- **Aerial 3D hyperstereos**
- **Museums**
- **Tabletops**
- **And lots more!**

I did an informal counting, and concluded that 50% of the images entered in our 3D competitions have no movement and could have been recorded with a single camera

There is a whole universe of people (Facebook, Instagram) who only use a phone for their 3D photography

Phone vs. Camera Picture Quality

- Debate on Facebook
- There are areas of photography where there is no comparison (sports, nature, etc.)

- **iPhone is optimized for good appearance on smaller screens**
- **Camera pictures look better blown-up/cropped** after some adjustments
- Nature Photography: **camera** (larger sensor) **wins**
- Low light indoors, mixed lighting, museums, etc., **iPhone 13 does surprisingly well**

Concerns

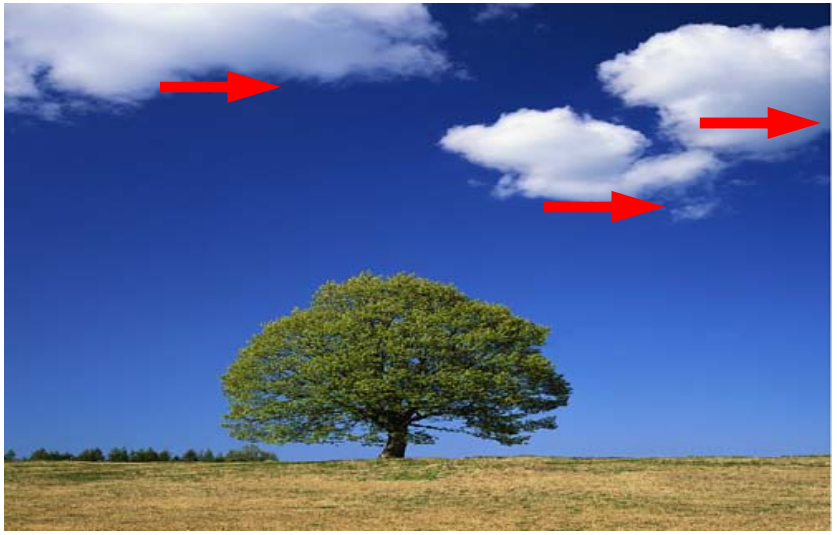
- **Alignment**
- **Direction of movement**
  (L→R, R→L?)
- **Amount of movement**
  (deviation)

There is a belief share by quite a few people that software alignment (StereoPhoto Maker, etc.) will correct alignment errors.

I am here to tell you that this is not correct. Attention to alignment during shooting is important!

Direction of Movement

Normally, **I take the left picture first** but some times there is a reason to take the right the picture first



- **Moving with the clouds, pushes the clouds back**
- **Moving against the clouds, pulls the clouds forward**

How much to Move?

Two extremes

1. Too little depth
2. Too much depth

- Between these two EXTREMES, there is a lot of ground for great stereo pictures.
- My recommendation: Deviation = 1.0 to 3.0 %
- Sometimes “less is more”. Be conservative!
- Bracket stereo base if you can

Easy Adjustment

Use SPM's East Adjustment function ("K" is your friend!)

Indication

Both Images(Anaglyph)

Left(Red) | Right(Cyan)

Flashing 20 x 10 ms.

Show Grid 17

Reverse Perspective Rotation

link both rotations together

100% SIZE

Edge detection

H. Position: 0

V. Position 0

Basic | Barrel | V_Pers. | H_Pers.

Focal Length: 50 mm - FOV=39.4 Deg.

35 | 50 | 75

Horizontal Perspective Rotation

L : 10.0 Degree

R : 10.0 Degree

Alignment Value

Restore(File) | Restore | Save

OK | Cancel

Phone vs Camera

Using your phone for 3D

- Your phone can be your **2nd "stereo camera"**
- It's **always with you** & **does not attract attention**
- **Small lens** & **water** & **shock resistant**
- Used **sequentially** offers **flexible stereo base**
- **Lots of possibilities** (stationary subjects)
- **3D Apps** help to **record** & **evaluate** 3D images
- **Image quality** is good & improves with time

I hope to inspired you and motivated you to use your phone for 3D. There are **resources** to explore for better use your phone camera and tips & techniques for single camera 3D