Pocket Microscope Slide Scanner

Product Requirements

Cost Requirement

- **Device will cost < $1000**

User Interface Requirements

- Minimal buttons
- Interface smartphone via Apollo app support
- Live view of slide
- Coarse and fine adjustments to adjust field
- TIFF and JPEG compliant
- Port for charging and slide loading

Product Requirements – cont.

Storage and Battery Requirements

- MicroSD card support
- Utilization on phone storage
- Connectivity with online cloud storage
- Minimum of 8000 acquisitions per charge cycle

Networking Requirements

- Wi-Fi (802.11 b/g/n compliant)
- Bluetooth 4.1 compliant
- 4G LTE when paired with smartphone

Product Requirements – cont.

Optics and Camera Requirements

- 20-40X effective zoom
- 0.25 µm/pixel resolution
- large format imaging capability (up to 1cm^2)
- LED light source (5600K)
- Auto white-balance (optional)
- Auto-focus

Product Requirements

Questions?

Discussion?

Comparable Products

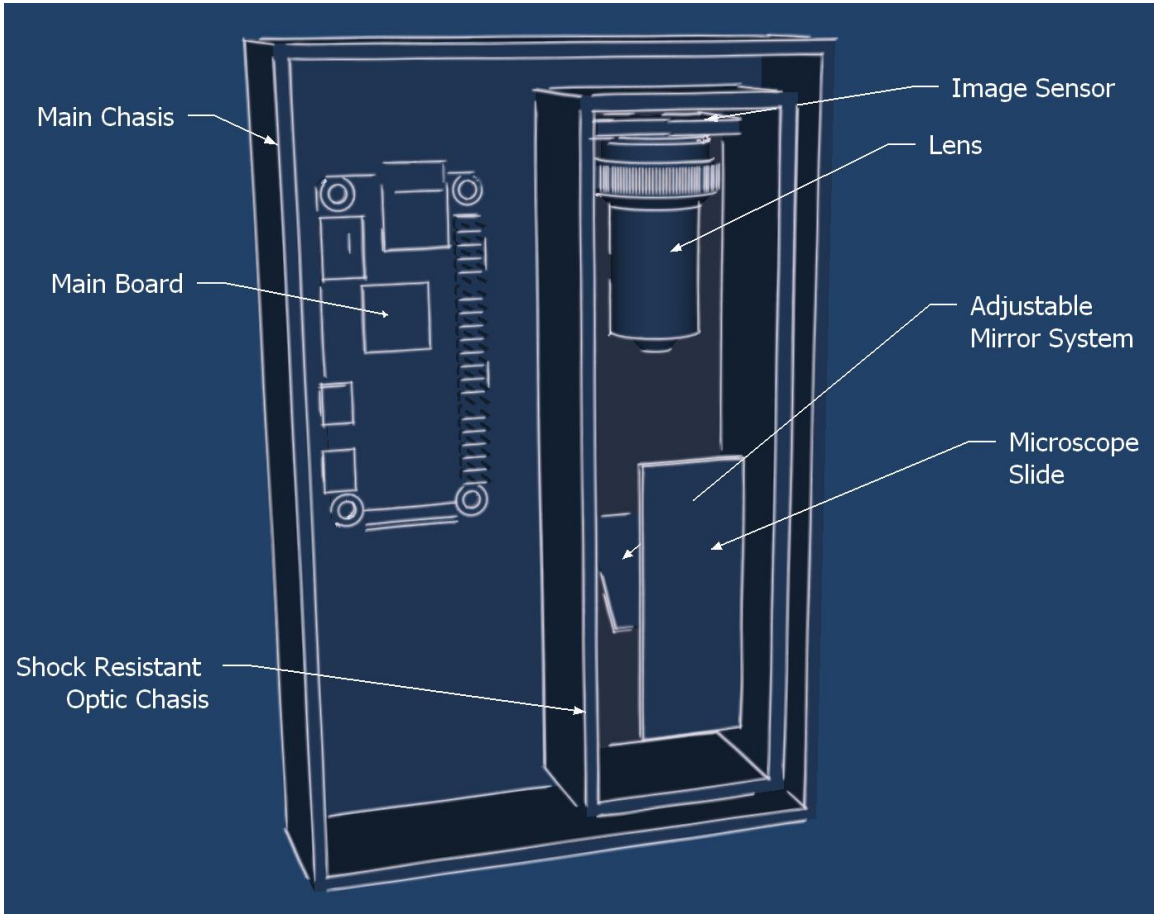
The PathScan Enabler 5: $1,895

- Typical scan times is just over 1 min.
- Includes two (2) holders which accepts two (2) 1 x 3" glass slides
- Optional geological polarizing holder
- 10,000 x 10,000 dpi resolution
- 2.54 µm/px

uSCOPE MXII Digital Pathology Slide Scanner: $10,000

- Whole slide imaging
- 0.25 µm/px
- Variable zoom (4x, 20x, 40x)
- Interfaces with PC, intended for desktops
- 1980X1080 resolution
- 24-bit color

Design Concept A



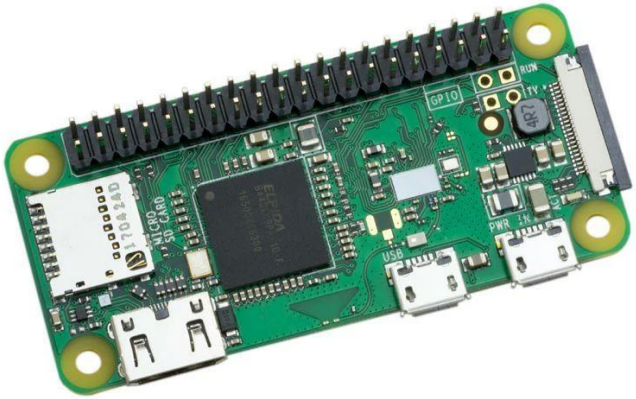
Concept A:

- Standalone and optimized device
- Utilizes a Raspberry Pi 4 to process and distribute image to phone
- RPi4 Compatible CMOS image sensor
- Bluetooth connectivity to phone
- Phone app for device control and image stitching

Design Concept A

Prototyping Materials Needed:

40X Lens
$135



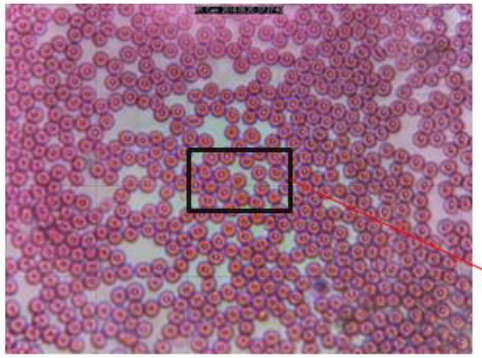
PiZero W
$10

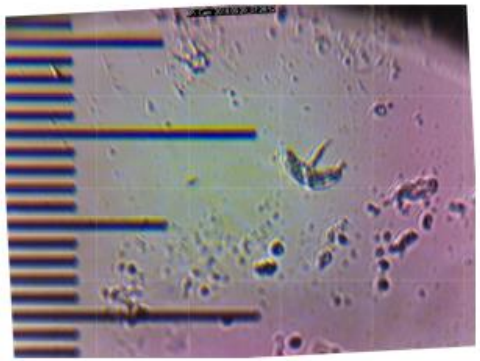
PiCam V2.1 (8mp)
$25

Design Concept A

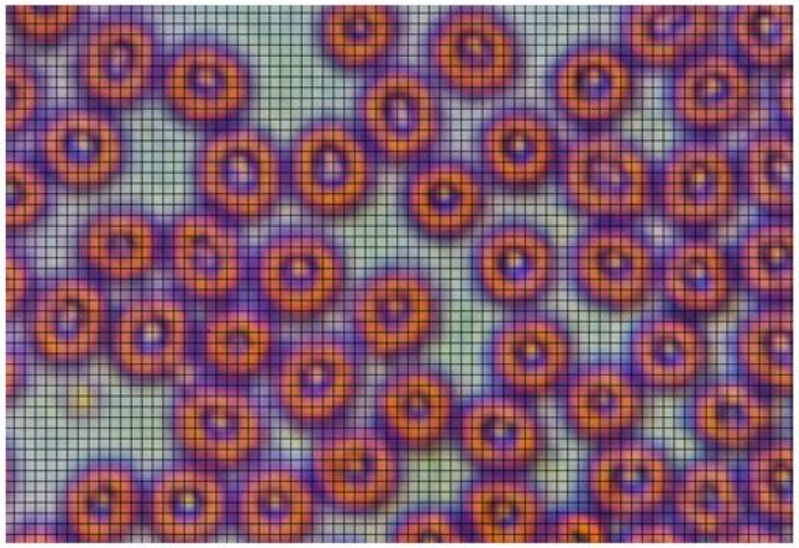
Image with Grid Overlay Transfer from Reference Slide

PI kit (v2.1, 40X microscope objective, red blood cells)





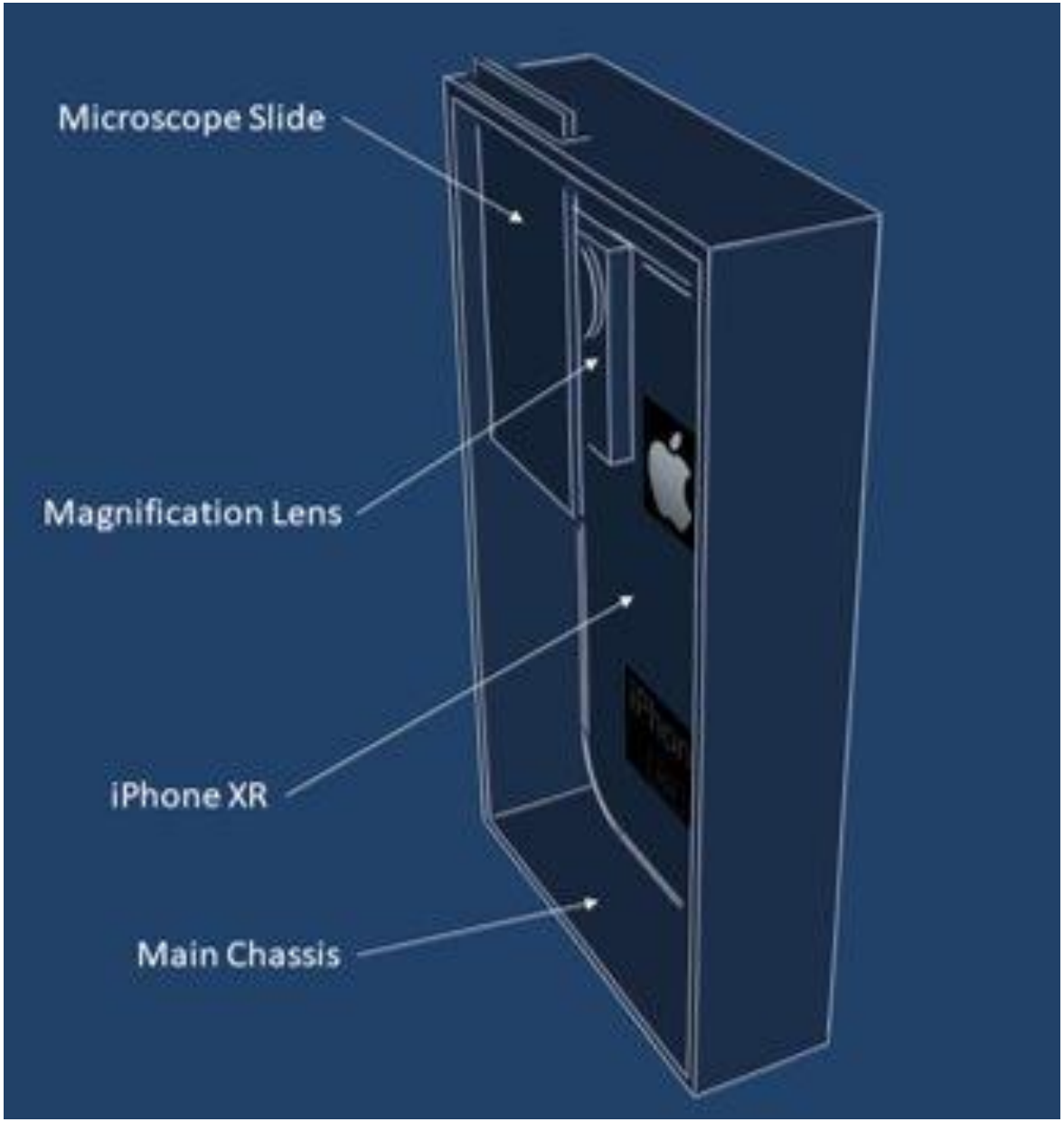
3280x2464 (quality =100)
50 micron grid spacing



3280x2464 (quality =100)
1micron grid spacing
High resolution zoom

~0.07 µm/px

Design Concept B



Concept B:

- Integrated as a phone case
- Magnification Lens is available as a consumer product
- Utilizes a phone for image capture, processing, and stitching
- Also requires a phone app for device control, stitching, etc…

Nurugo Sample Photos

- Hypothetical 400x, actually 15x Magnification
- Small and lightweight (3.89g, 0.5cm thickness)
- No battery or power requirement
- Completely passive

Tested Phones

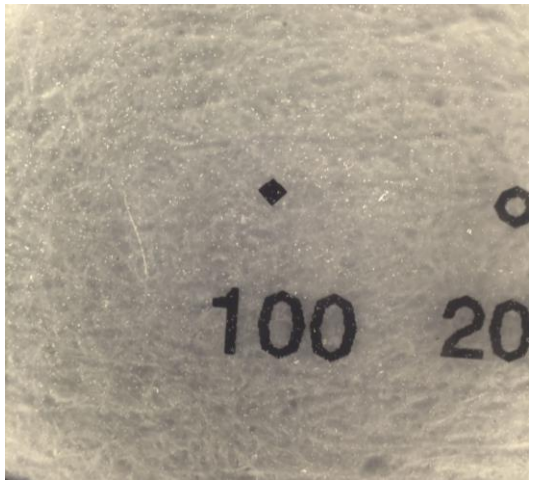
Samsung Galaxy S9

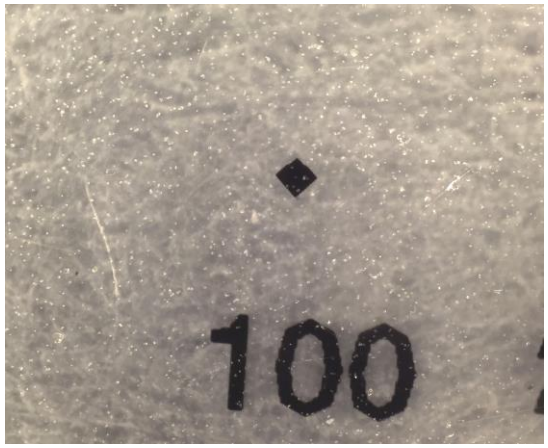
REVIEW
SPECIFICATIONS
READ OPINIONS
PICTURES
360° VIEW

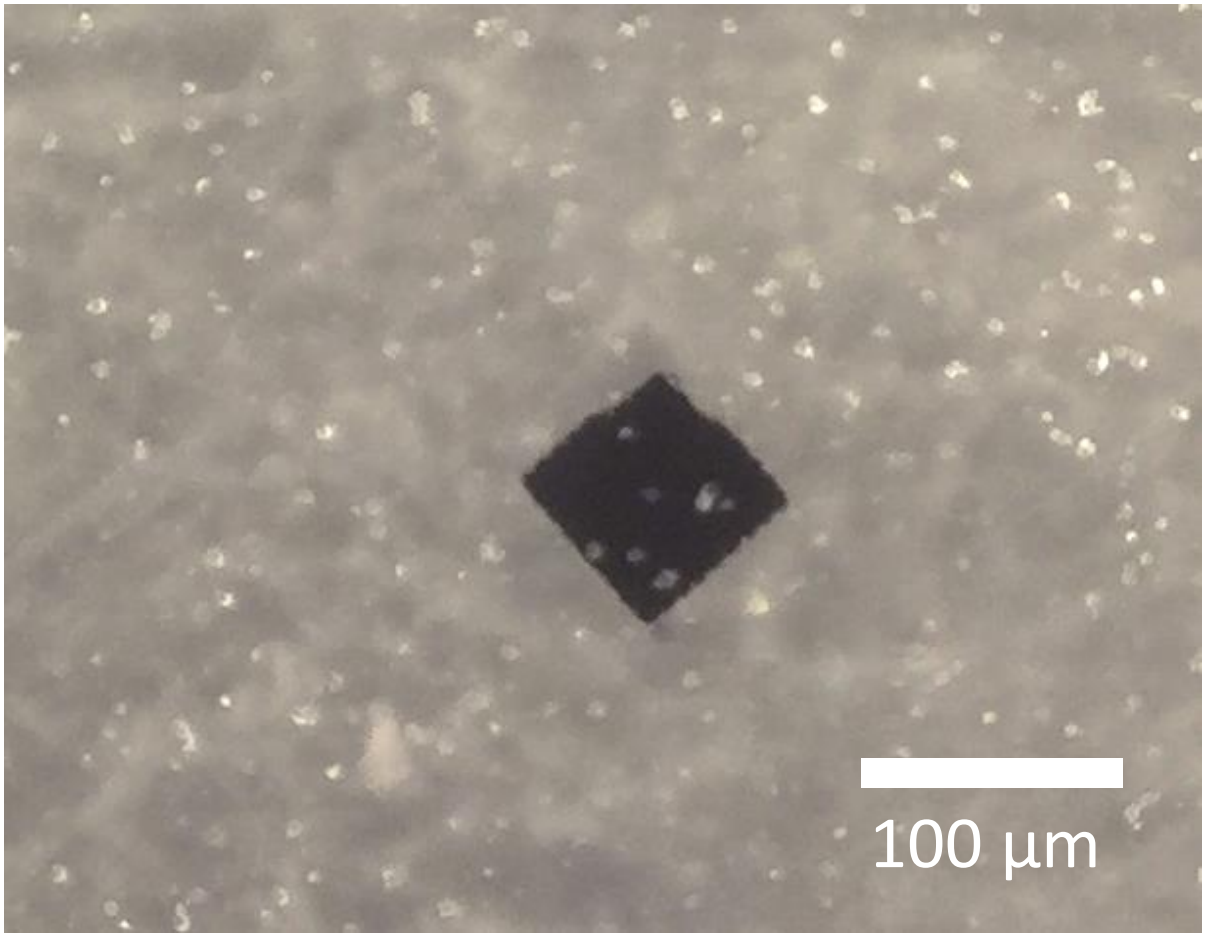
Apple iPhone 6 Plus

REVIEW
SPECIFICATIONS
READ OPINIONS
PICTURES
360° VIEW

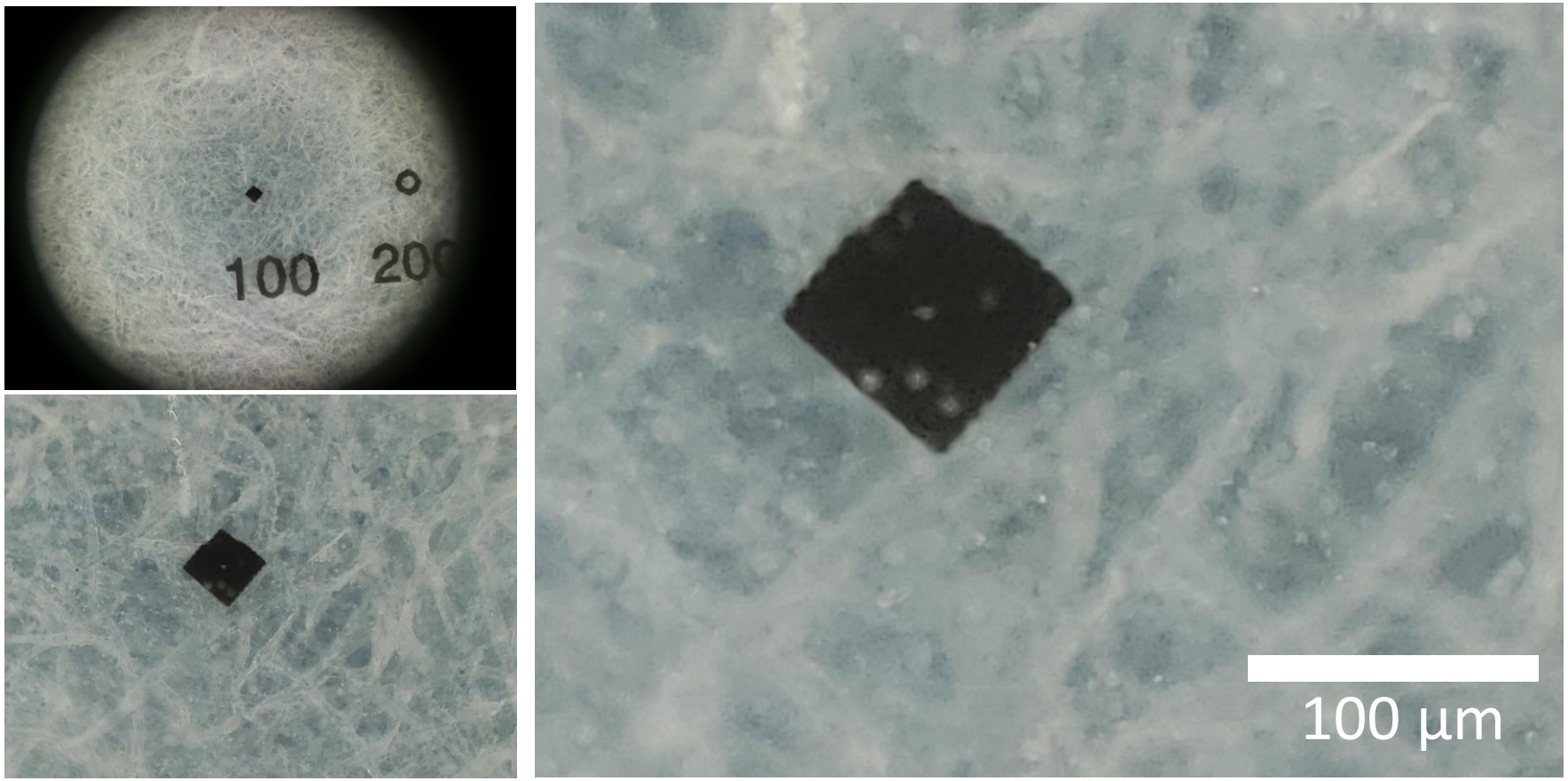
MAIN CAMERA	Modules	12 MP, f/1.5-2.4, 26mm (wide), 1/2.55", 1.4µm, dual pixel PDAF, OIS	8 MP, f/2.2, 29mm (standard), 1/3", 1.5µm, PDAF, OIS
	Features	LED flash, auto-HDR, panorama	Dual-LED dual-tone flash, HDR
	Video	2160p@30/60fps, 1080p@30/60/240fps, 720p@960fps, HDR, dual-video rec., stereo sound rec., gyro-EIS & OIS (30fps)	1080p@60fps, 720p@240fps







Achieved with iPhone 6 Plus ~0.78 µm/px



Achieved with Galaxy S9 ~0.73 µm/px

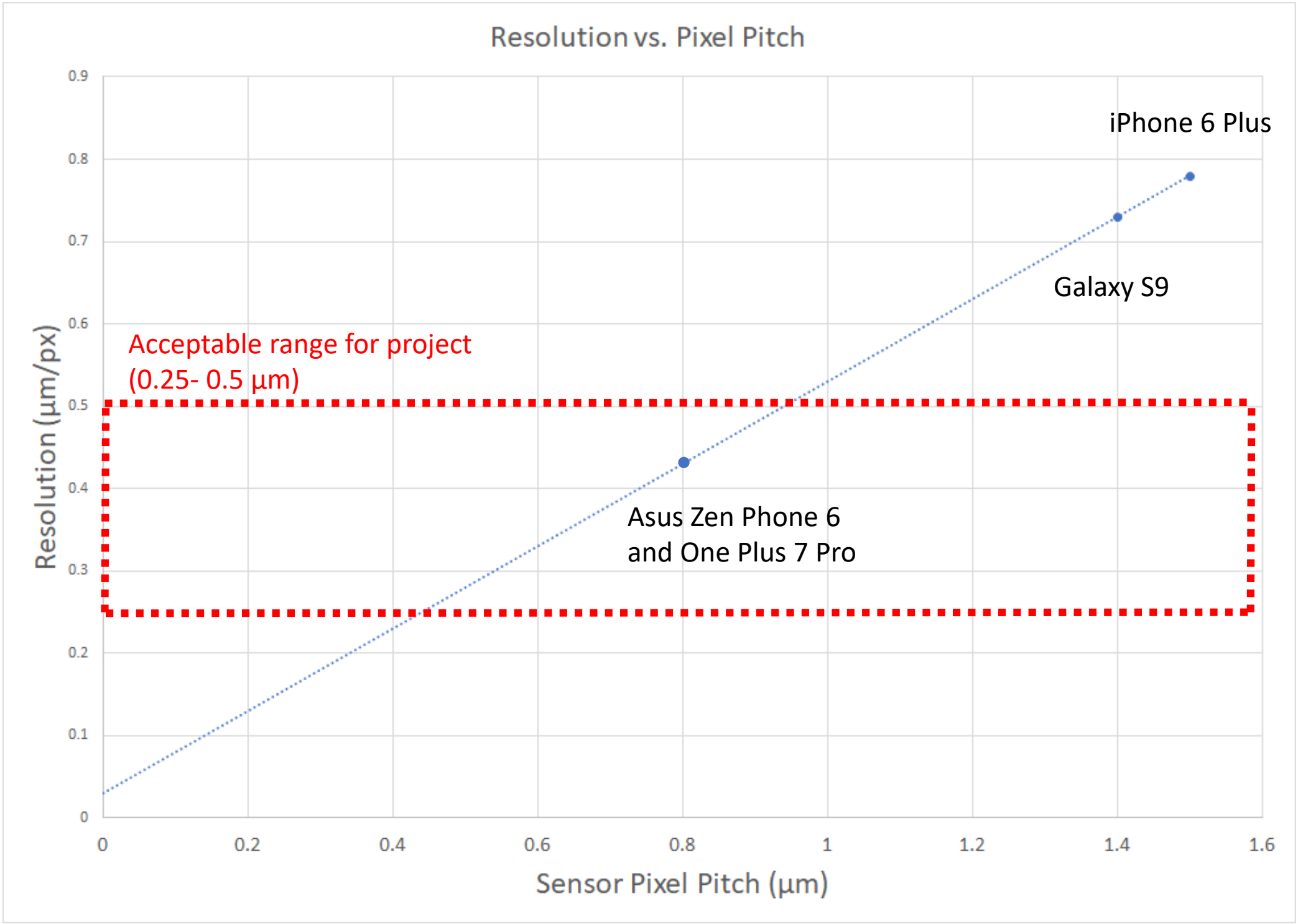
Pixel Pitch

Why is this important?

Pixel pitch is the space that each pixel occupies on a given image sensor.

Main constraint behind Design Concept B

- Smaller pixel pitch=greater µm/px
- Smaller pixel pitch decreases signal to noise ratio (bad)
- Usually how phones achieve higher resolution images
- Even phone with best camera option will only achieve


Resolution vs. Pixel Pitch
Resolution (µm/px)
Sensor Pixel Pitch (µm)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
iPhone 6 Plus
Galaxy S9
Acceptable range for project
(0.25- 0.5 µm)
Asus Zen Phone 6
and One Plus 7 Pro

Potential Phones

Asus Zenfone 6 ZS630KL

REVIEW
SPECIFICATIONS
READ OPINIONS
PICTURES
360° VIEW

OnePlus 7 Pro

REVIEW
SPECIFICATIONS
READ OPINIONS
PICTURES
360° VIEW

48 MP, f/1.8, 26mm (wide), 1/2", 0.8µm, PDAF, Laser AF	48 MP, f/1.6, (wide), 1/2", 0.8µm, PDAF, Laser AF, OIS
13 MP, f/2.4, 11mm (ultrawide)	8 MP, f/2.4, 78mm (telephoto), 3x zoom, PDAF, Laser AF, OIS
	16 MP, f/2.2, 13mm (ultrawide), AF
Dual-LED flash, HDR, auto panorama (motorized rotation)	Dual-LED dual-tone flash, panorama, HDR
2160p@30/60fps, 1080p@30/60/240fps, 720p@480fps; gyro-EIS (except @240/480fps)	2160p@30/60fps, 1080p@30/60/240fps, 720p@480fps, Auto HDR, gyro-EIS, no video rec. with ultrawide camera

$500

$600

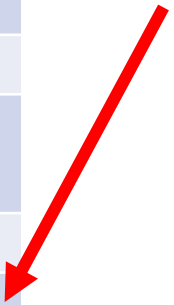
Image Stitching

- Python
- OpenCV
- Limiting Factors
  - Computational power required

Live Stitching Feasibility:

Calc. :(scene.width/subject.speed)*(display.pixel.pitch/display.total.width)

Minimum Shutter speed needed:		
	Scene Width	353.5um
	Subject Speed	0.01m/s
	Sensor Pixel Pitch	1.4um
	Sensor Width	5.4mm
	Shutter Speed	~9.1E-06secs



Shutter speed not feasible with sensors available

App Development

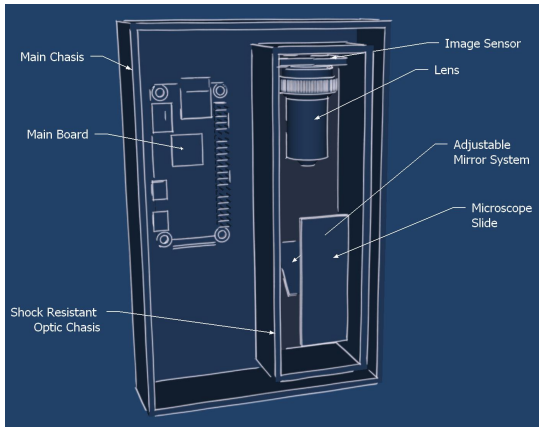
Android

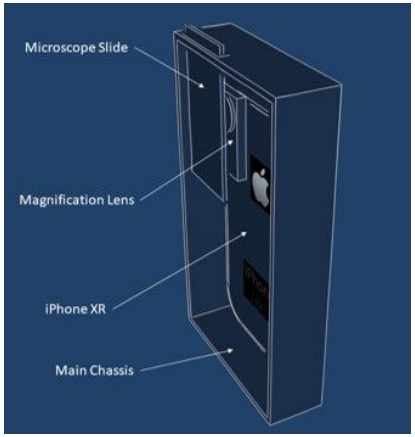
- One-time $25 registration fee to publish app
- Development OS not restricted
- BeeWare

Apple

- Annual $99 fee to publish app (unless nonprofit)
- Must submit app for review before upload
- Development OS restricted to Mac
- BeeWare

Design Conclusions





Concept A

Pros:

- Superior image quality by a factor of 10
- Longer product life
- Less Cost

Cons:

- Larger form factor
- More software development

Concept B

Pros:

- Smaller form factor
- Simpler design
- Easier to implement
- Less peripherals

Cons:

- Lesser image quality
- More cost

Schedule

Task Description	Duratio	Assigne	
Testing Nurugo Micro	2 weeks	10-Oct	FALL
Finalize appropriate path for design	2 week	17-Oct	
Brainstorm Cirteria for design validation	1 week	17-Oct	
Brainstorm and submit project value Proposition	1 week	24-Oct	
Build and update Wikipage	3 weeks	24-Oct	
Sanpshot #2 Preparation	1 week	26-Nov	
3D Modelling of device	2 week	3-Nov	
Visit Client at Portand	2 days	24-Nov	
Review Budget and Track progress	1 week	8-Dec	
Design Expo Resitration	1 week	21-Jan	SPRING
Prototyping	3 weeks	15-Jan	
Stress Analysis on enclosure	2 weeks	2-Feb	
Design Validation Analysis on the prototype	2 weeks	9-Feb	
Engineering Release review	1 week	16-Feb	
Sanp Shot #3 Preparation	1 week	28-Feb	
Report Writing-1	2 weeks	6-Mar	
Expo Preparation	3 weeks	12-Apr	
Finalize design Porfolio and Report	2 weeks	28-Apr	
Poster Preparation	1 week	1-May	