Pup – The connected pocket scanner

Product Requirements Document (PRD)

Document Revision Block

Rev:	Date:	Revision Description:	Edited By:
A	Jan 5th 2017	Initial Release	Renaud Pelissier
B	March 28th 2017	Pre-Evt 2 Release	Renaud Pelissier

Table of content

Product Concept Summary

Product Description

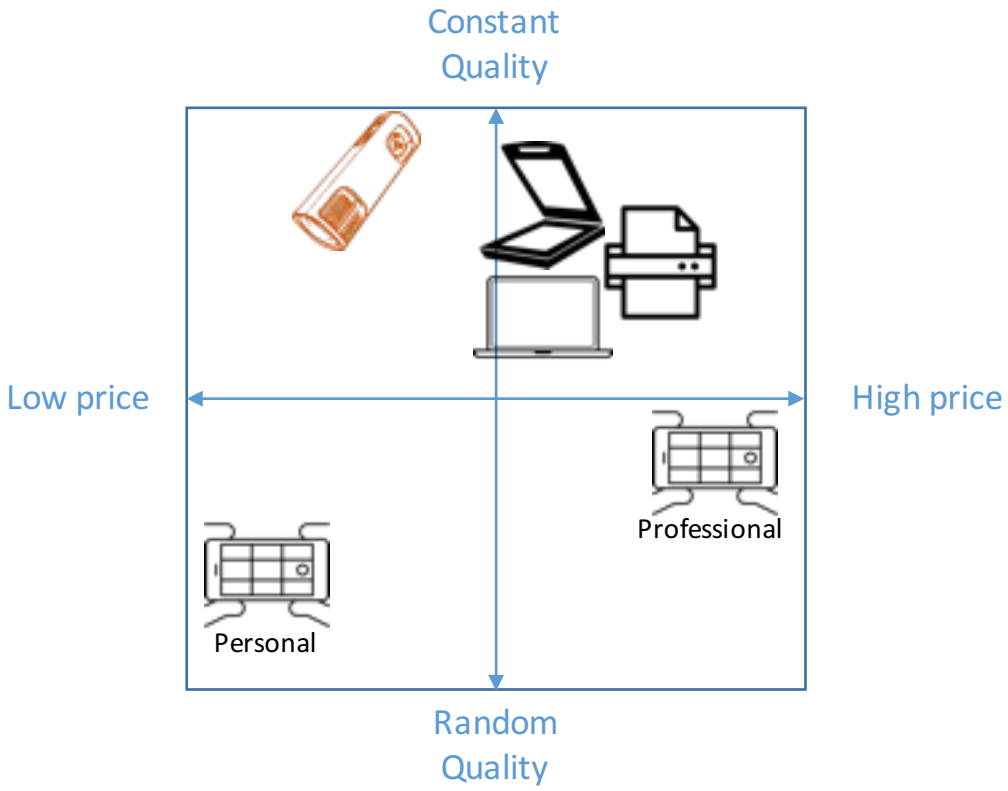
Describe the complete product system, including accessories, packaging, software, and services platform.

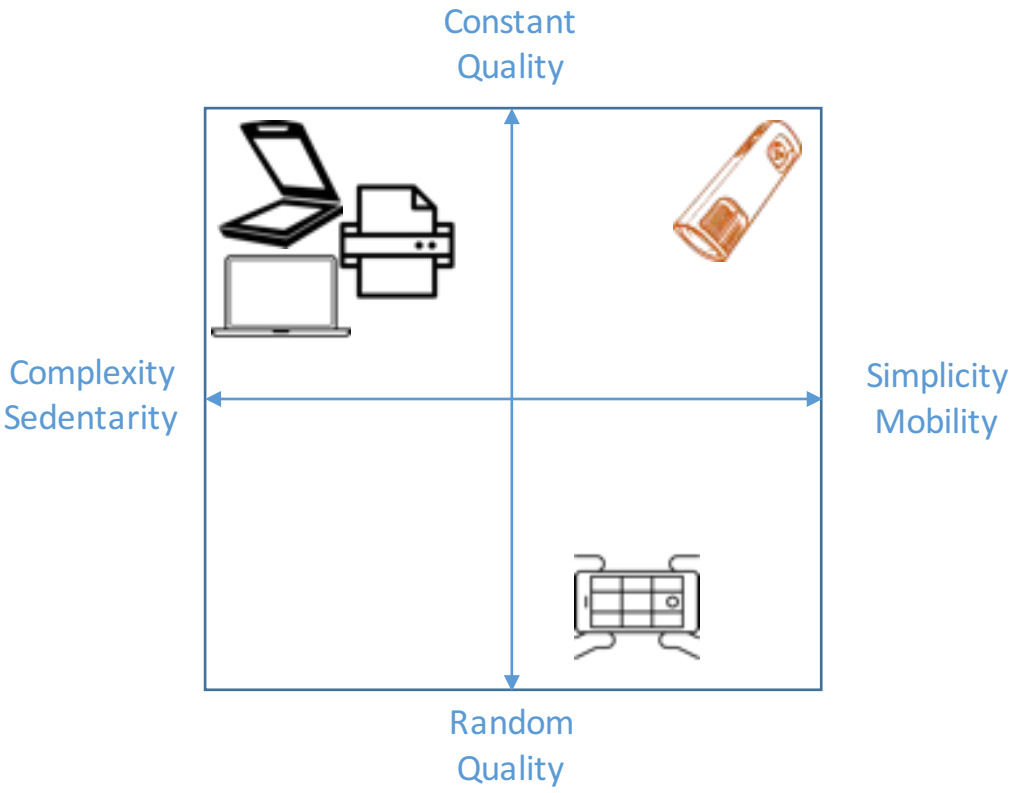
The Pup is the first ever connected pocket scanner.
It is mobile: tiny, lightweight, wireless, with a long-lasting battery. The Pup is very simple to use thanks to its unique button.
It is smart: it automatically takes care of every step, from your sheet of paper to its destination on the internet.

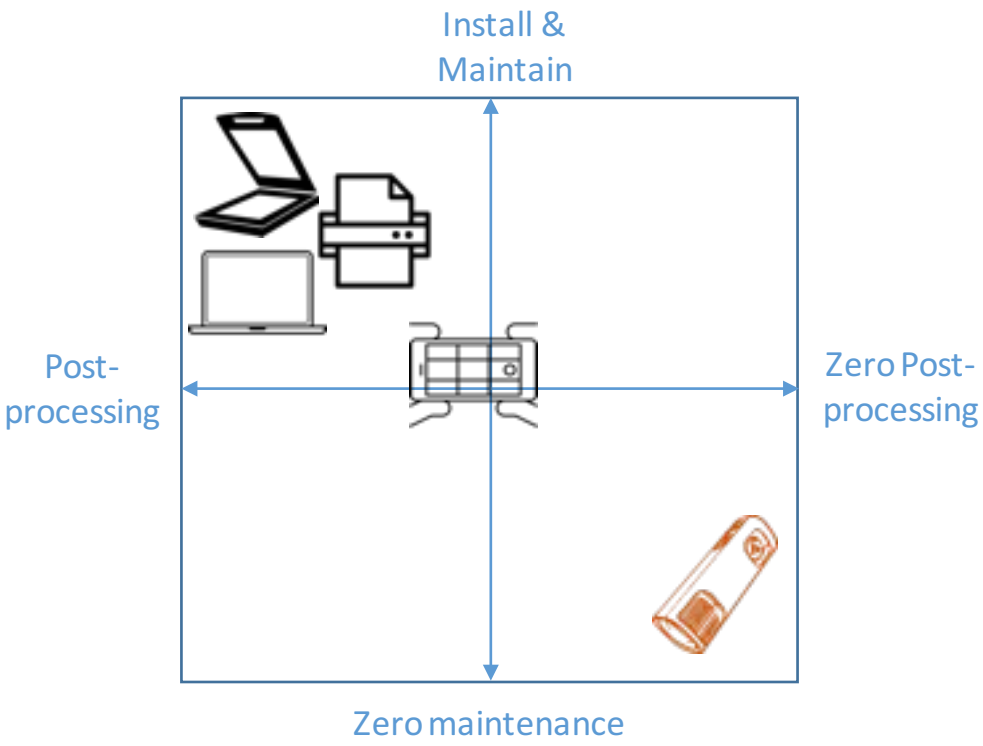
Value Proposition

Describe the basic value proposition of the product. Why will users buy it? How is it better than or different than existing product offerings? What is the pivotal feature or feature set that makes it great?

Pup is a new kind of document scanner.
It is simple to operate. It is cheap. It offers a very good and constant quality. It does not rely on a smartphone or a computer. It has a very innovative and cool laser aiming system.



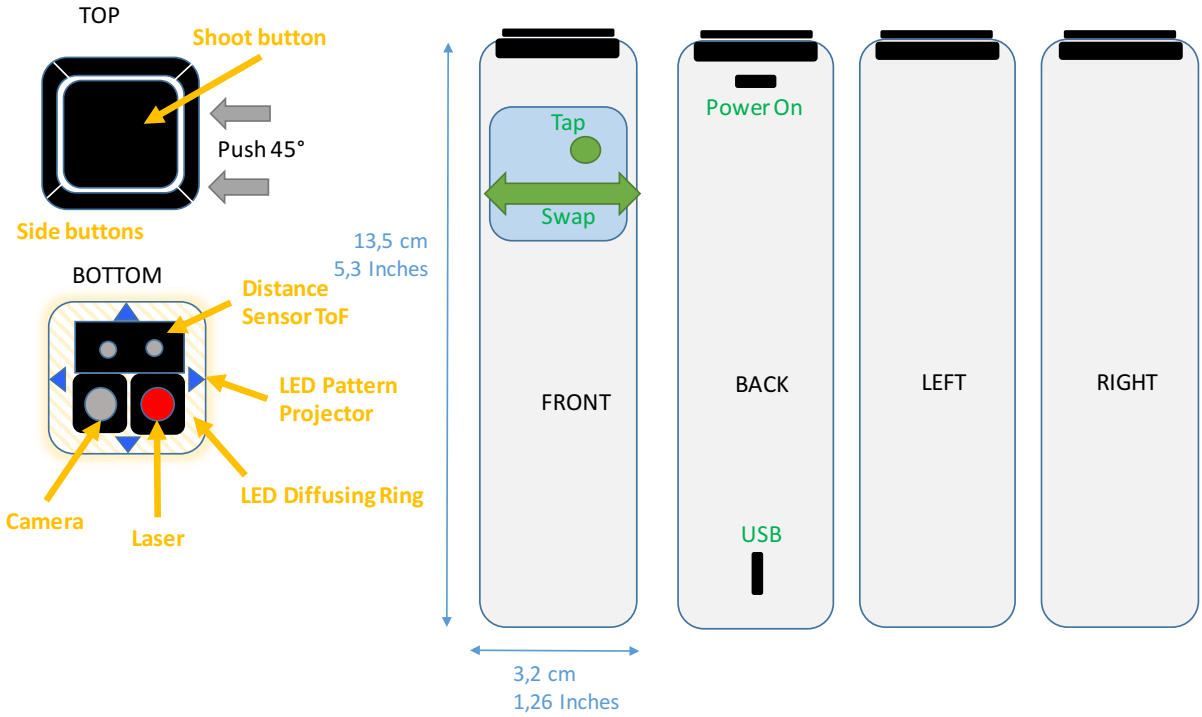


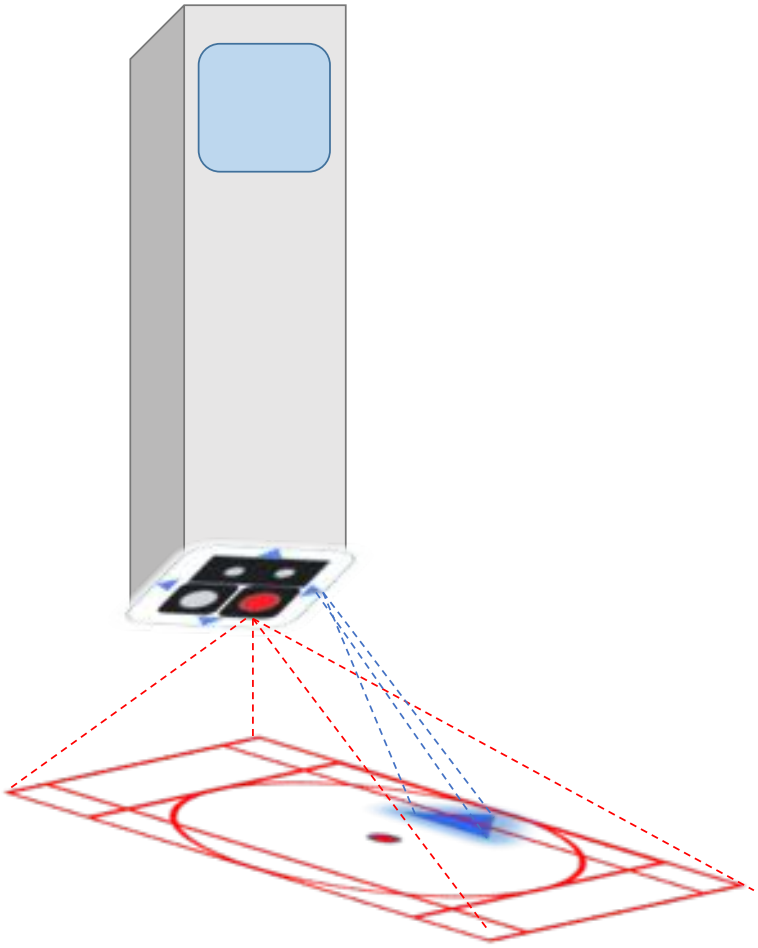


Difference with the Smartphone : the main challenger

Feature Set

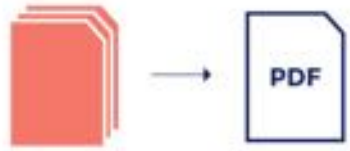
List the major feature sets of the proposed product. Besides the functional attributes, be sure to include connectivity, charging, and compatibility with ancillary products.





And even more !

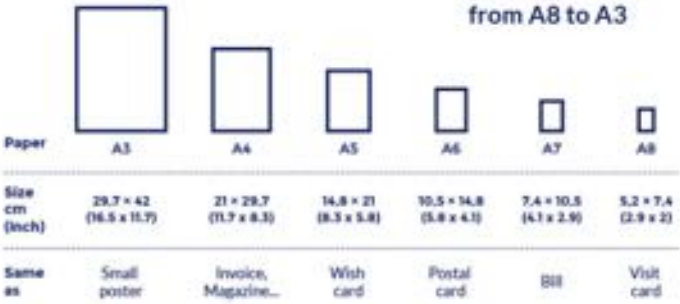
Auto-crop	Auto-rotate	Auto-compress	Auto-upload
Sharpness control	Anti reflection	Curve fixing	Battery life of 12h
10,000 pages offline memory	OCR to Word & Excel	Color or Black& White	High level security
Wireless	Wifi Bluetooth	7,0 oz (200 g)	A3 to A8



Multiple Pages to PDF / X

Mosaïc feature
Automatic process for bigger size (from A2 to what you want!)

Any size from A8 to A3



- Auto-crop (software)

The laser window is used to indicate where to crop the image

- Auto-rotate (software)

The top had button is used to indicate page orientation (see below)

- Auto-compress (software)

The distance sensor is used to optimize image size and compression (see below)

- Auto-upload (software)

Once the scenario is chosen, the system will upload page automatically and send it according to the scenario. If no WiFi is available, the system waits untile WiFi is back and resume sending images.

- Scenario feature (software)

Scenarios are used to store a set of parameters standing for a particular use case (see below).

- PDF assembling (software)

When multiple paged are captures, they can be stored in a single PDF file.

- Mozaic feature (software)

When the document is larger than A3, we offer a way to keep having a nice quality by allowing to capture the image using multiple subparts captures of higher resolution.

- Sharpness control (software)

Sharpness analysis is a post processing made on the image. It is a mathematical analysis on different zones of the image too compute a sharpness indicator. The result is binary OK or KO. If KO we vibrate and the user has to restart.
We want it to be fast (<500ms) because we need to tell the user to do it again before it has proceeded to the next page.

- Anti-reflection (optical and software)

Some filters (such as polarizing filters) are used to avoid having a ghost image of the flash itself. (see below)

- Anti-burn lighting (optical and software)

The challenge for high quality image is to get a very homogeneous light over the captured area. Doing this you avoid “burn” effect : a white stain (blob) due to local saturation of photon receptors on the sensor. (see below)

- Curve fixing (software)

The paper page, when bound in a book, use to be curved. The result is a bad looking image. We want to fix this by post-processing the image using data from the image intensity profile maybe using multiple image with different exposure duration.

- Rechargeable battery life 12h

The device is powered by a rechargeable battery. It should last 12 hours in usage. It should last several days when sleeping.

- 5,000 pages offline memory

When no WiFi is available, the pages are stored locally on a memory. The memory capacity should be of 5,000 pages, 1,5MB each. This means around 8GB.

- OCR to word and excel

This feature will be done on the cloud as a post processing feature.

- Color, Gray, Black’n White (software)

Chose the color of the image (when creating the scenario)

- High level security (software)

Encrypted local storage, encrypted uploads (SSL/TLS, AES 256)

- 200g

200g to 300g seems fine.

- A3-A6

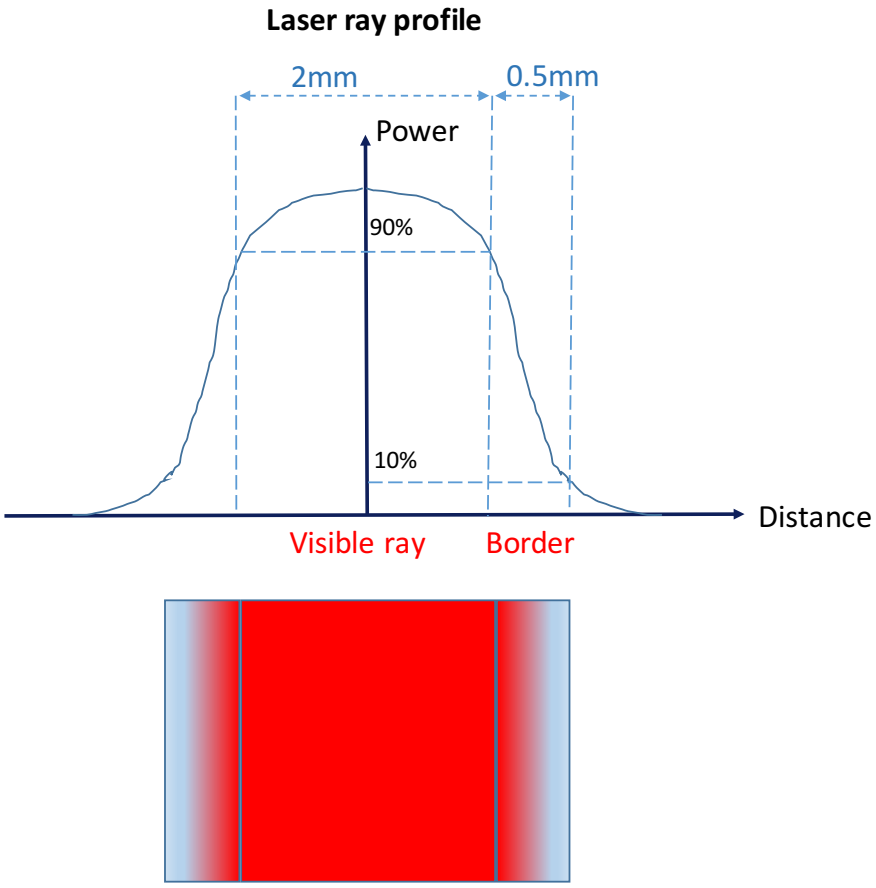
We want to be able to capture any size of document for A3 to A6 (nice to have A8)

format A			
Taille	mm x mm	po x po	Pixels à 300 ppp
A0	841 × 1189	33.1 × 46.8	9930 × 14040
A1	594 × 841	23.4 × 33.1	7020 × 9930
A2	420 × 594	16.5 × 23.4	4950 × 7020
A3	297 × 420	11.7 × 16.5	3510 × 4950
A4	210 × 297	8.27 × 11.7	2481 × 3510
A5	148 × 210	5.83 × 8.27	1749 × 2481
A6	105 × 148	4.13 × 5.83	1239 × 1749
A7	74 × 105	2.91 × 4.13	873 × 1239
A8	52 × 74	2.05 × 2.91	615 × 873
A9	37 × 52	1.46 × 2.05	438 × 615
A10	26 × 37	1.02 × 1.46	306 × 438

- Wireless
- Charging via USB wall adapter.

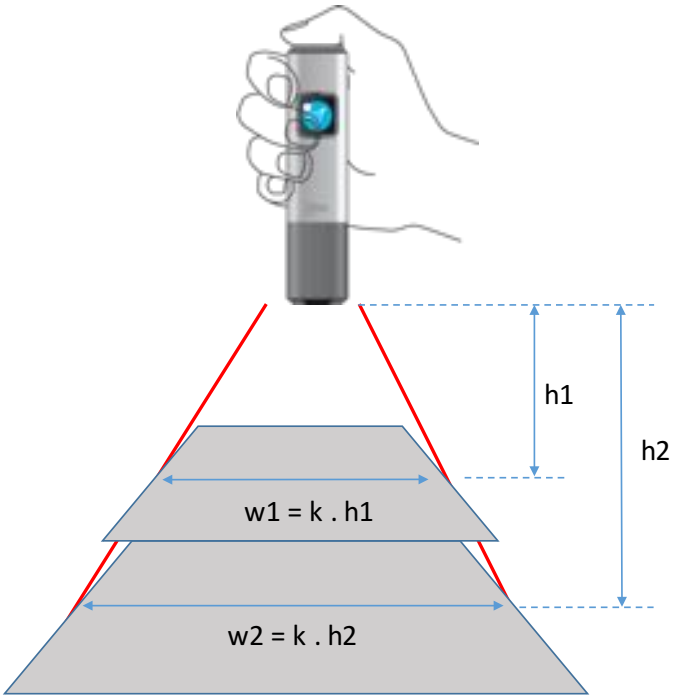
Laser aiming

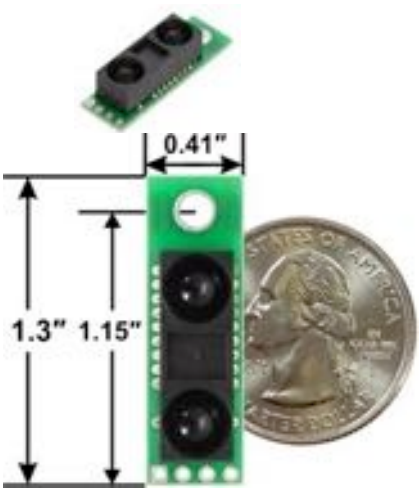
A laser is used to define the capture area.
It is a rectangle window of "type A" (ratio $\sqrt{2}$).
The lines need to be sharp and thin.



Distance sensing

Knowing the distance between the camera and the sheet of paper is a valuable data. It allows a lot of optimization and allow to avoid over-quality that can dramatically increase bandwidth consumption.





Anti-reflection

The anti-reflection system is used to avoid white marks on the center of the page, especially on glossy papers.

Reflection

No reflection

Curve correction

When pages are bound together, such as in books, the sheet of paper is not flat and the image will need post processing for fixing this issue.

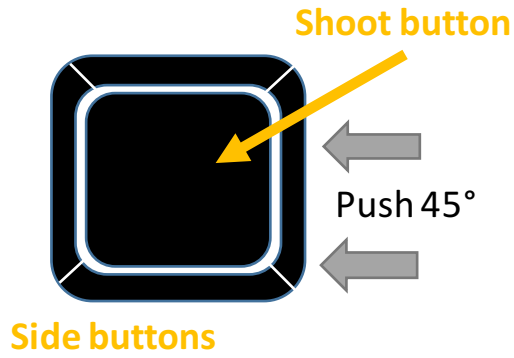
Lighting / Anti-burn

To get a high quality over the whole area of the image, lighting is a key point. It needs to be very homogeneous to avoid burn effect (white over exposed area).

Top hat button

The top hat button has two functions :

1. Turn the laser on for starting the capture
2. Shoot the page
3. Choose over the 4 options: Back, Front, Left, Right



Web/App Scenarios

Scenarios are created online on either a computer, smartphone or tablet.
Image settings can be:

- Image color
- Image quality
- Assembly format : zip, pdf, individual images
- Image format GIF, JPG, PNG…

Destination can be:

- Google Drive
- Dropbox
- Email
- …

COGS, FOB, & MSRP Targets

List the target COGS and FOB targets as well as the MSRP assumption for the product. Be sure to include the annual manufacturing volume level associated with the values. For CE products sold direct to consumer, a mark-up of 2x FOB (50% margin) is typical.

TODO needs more accuracy

FOB HK :
Volume 2017 : 10K units
Volume Q1 2018 : 20K units

Product Roadmap

Describe the evolution of the product over the next 2 to 4 years. Is the product a line extension of an existing product line? Will it start a new product line? How will the feature set evolve over time? What accessories will follow as part of the product ecosystem?

Version 1

Only one version of firmware, only one version of USB charging cable, no wall charger provided.

Next versions features

- real time document projector (for use with stand accessory)
- macro scanning and colored lighting for skin disease recognition
- microphone and speaker with speech2text for joining text message to a picture
- multi user device with an identity sensor

Accessories

- desktop lamp stand (3in1: lamp + document scanner + document projector)
- charging dock
- anti-choc casing

Roles

7Next is responsible for high level software development

- This includes using well known Object language (Java, Python, …) to do:
  - Web dev : any external cloud server and service
  - On Device dev : high level business logic (dealing with images, files, web transfert, business logic)
- This does not include :
  - Driver implementation for modules such as CMOS, Wifi, Display…
- We are not sure about who should deal with development of tools for updating the Embedded Operating System TODO

Industrial Design Requirements

Color, Material, & Finish

List any materials that are deemed a requirement to achieve the ID vision for the product. Metal exterior enclosures, glass, textiles, specific finishes (gloss, mirror finishes. PVD), and color matching.

Only one color.
The quality of finishing should be PREMIUM: high grade. Reference is Macbook Pro.

CMF details to be provided soon.

Product Versions & Configurations

List any known permutations of the product including color schemes, premium and budget versions, limited editions, and sizes.

TODO

Rendering

TODO

User Experience Requirements

Use case

Describe the user interaction with the product under both normal and extreme conditions. Be sure to include average number of interactions per day, expected battery life, expected product abuse, and possible extreme use cases. Also include all the various environments that the product could be found.

Regular use

1 PICK UP

Choose
your scenario

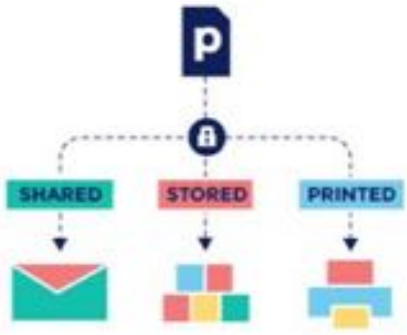
2 PRESS

Fit the laser
to the pages
and press the button

3 PUP

That's it!

Your document is
already on its way
to its destination



Out-Of-Box Experience

List any specific expectations or requirements around experiencing the product for the first time (removing the product from the packaging and initial exploration).

Basic installation: no App required

To connect the Pup with the local WIFI access point, we use a smartphone or computer to generate a QRCode that contains credential informations.
The Pup can then scan this QRCode and extract useful information to connect to the WIFI.

Advanced installation

The Pup is configured as an access point waiting for a connection.
A smartphone has the App installed which has a valid Wifi connection. When the app is launched:

1) the active WiFi credentials are stored in the memory for later use
2) the WiFi is disconnected and is instead connecting to the Pup access point
3) the stored WiFi settings are loaded into the Pup.
4) the App is restoring previous WiFi connection on the smartphone
5) the Pup is now ready to connect and show a welcome message on its screen

Product External Parts

List all the relevant touch points on the product that the user is expected to interact with. Include buttons, switches, input surfaces, handles, grips, areas of tactile interest, etc.

- Touch screen
- Top hat with shoot button and 4 directions button
- An independent on/off button
- Camera
- Laser (aiming window projector)
- Distance sensor (to know the original image size)

- High Power Led (to illuminate the scene)
- Vibrator (for mechanical feedback)
- USB micro female
- LED Orientation Pattern Projector

Human Factors & Ergonomic Considerations

List any interaction points of the product where consideration of human factors will be important. Wearable products should include expectations on the size range the product should be compatible with; include max input force requirements, readability/legibility of text, weight and size considerations for handheld products, user comfort, and user confusion issues. Consider indicator recognition, audible queues, max level of sound emitted (fans, motors), etc.

TODO

On-Line Product Support

List any plans for supporting users with on-line information, user groups, and customer support services.

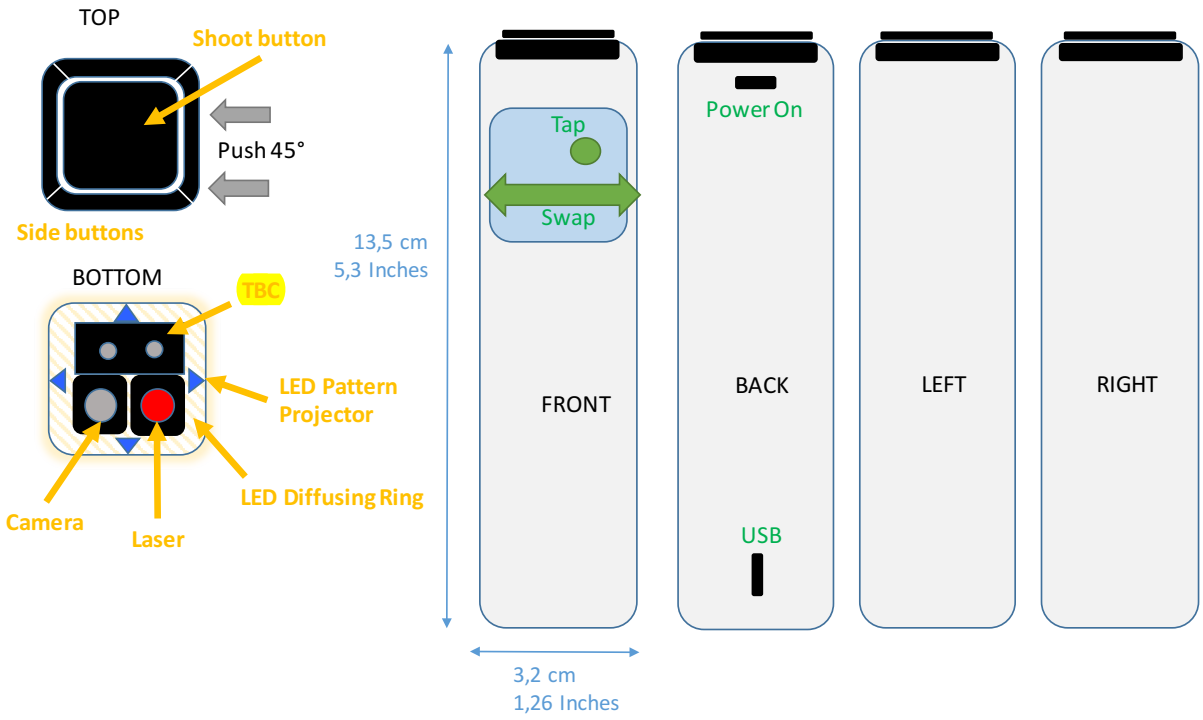
TODO

Physical Requirements

Product Size

List any critical product dimensions and control surface sizes that must be met, and describe why it is a hard requirement. If specific dimensions are not required, state that these dimensions are reference and are allowed to change as the design develops.

Dimensions: 135x32x32mm



Product Weight

If weight is a concern or critical to function or user experience, it needs to be measured. If not, state that it is a reference and not critical to function.

Around 200g

Artwork, Logo, & Labeling

Include any requirements on product labeling and branding. Include specifics around secondary operations (laser marking, pad printing, hot stamping), badges, decals, and in-molded graphics.

Label for Laser Security will be mandatory.

TODO

User Inputs

List any required control surfaces or input features such buttons, switches, capacitive touch areas, levers, or triggers. Include any specific gesture requirements for each input such as stroke length, input force, click feel, etc.

Top hat button : aiming, shooting, orientation choosing
Touch screen : choosing a scenario

Information Outputs

List any physical indicators on the product including light indicators, displays, audio queues, and haptic feedback. Also include any data-out interfaces such as connectors (audio jack, microUSB) or RFID tags.

Screen display : system state and scenario
Vibrator : feedback when bad capture happen and needs to be done again

Material Requirements

List any product materials that are not negotiable, such as non-metal enclosures for wireless connectivity, avoiding certain materials due to allergy concerns, metals for thermal performance, ROHS compliant materials, or special coatings to address specific environmental exposure concerns.

TODO

Electrical Requirements

List any known hardware components that will be required to achieve the product performance requirements.

Requirements are split into 3 levels of importance:

- Minimum Required Features: absolutely necessary for offering a valuable product
- Sold Features: features already sold to some clients, we should make them if "not to hard"
- Nice to have: ideal features for this V1, we need to discuss the feasibility

Source : Excel files provided and named like this document

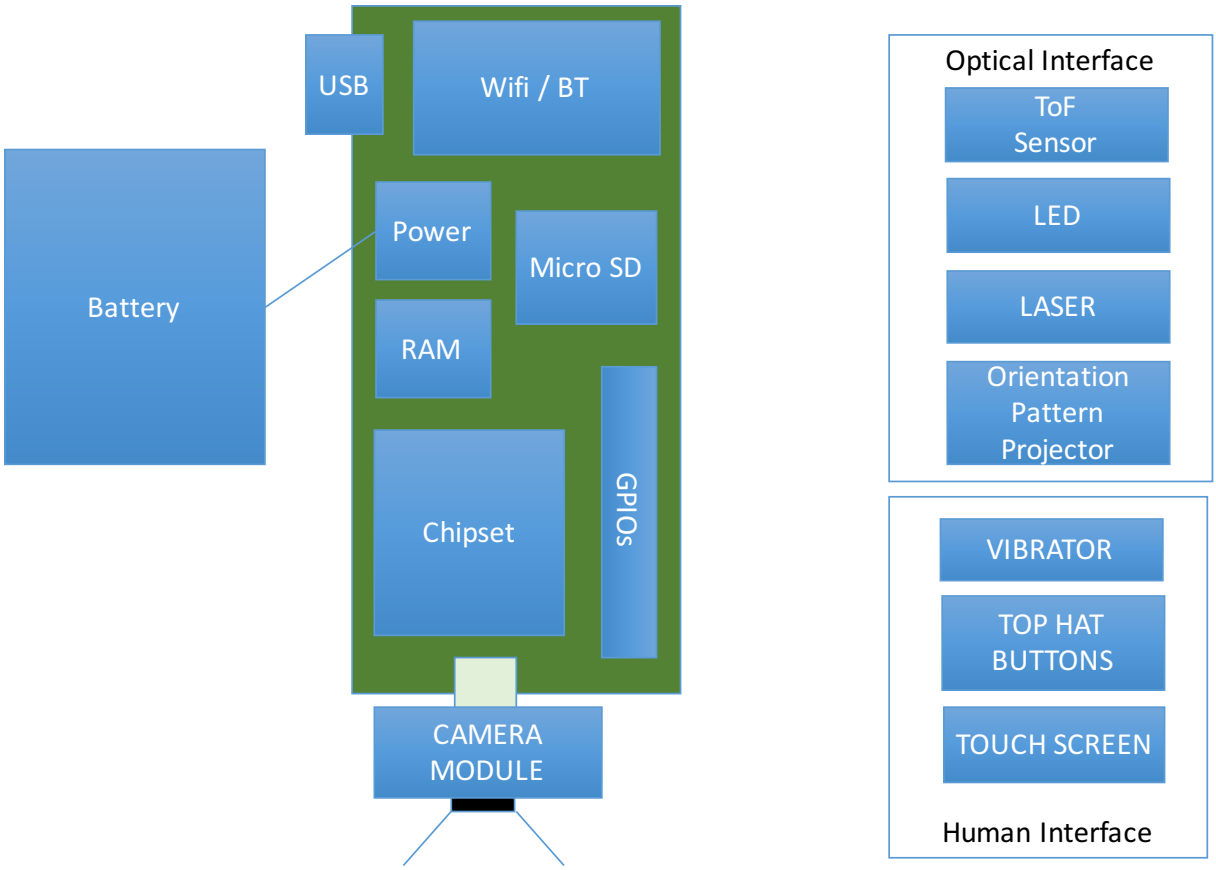
	Minimum Required Features	Sold Features	Nice to Have Features
EE **Camera**			
	- 13 MP		- 20 MP
	- with autofocus		
	- focus distance 10cm - 50cm		- focus distance from 5cm to infinity
	- focus speed < 500ms		
	- sensor dimension : ~= 8x8x6mm		
	- FOV (angle of aperture) : ~70°		
EE **Touch screen**			
	- with touch pad		
	- dimensions ~1.3-inch		
	- resolution : reference is smartwatch		
	- square(ish)		
	- 320 x 320 pixels, 278 ppi		
EE **Wifi**			
	- used for uploading to the cloud		
	- Wi-Fi 802.11 a/b/g/n, dual-band		
	- hotspot		
EE **USB**			
	- micro USB		- type C USB
	- for charging		
	- for PC audit, debug and firmware upgrade		

EE	**Microcontroller**			
		- boot duration < 10s		
		- low consumption		
		- QRCode reading + JPG compression capabilities		
OE	**Orientation pattern projector**			
		- blue indicator visible by any light condition from 10cm to 50 cm		- sharp triangle pattern
OE	**Laser module aiming**			
		- red laser diode		
		- diffractive Lens (DOE) generating rectangle window		
EE	**Battery**			
		- 12 hours usage		
		- 5 days sleeping		
		- Built-in rechargeable lithium-ion battery		
		- Charging via USB to computer system or power adapter		
ME	**Top hat**			
		- center button for turning laser on and shooting		- button replaced by proximity sensor for turning laser on
		- 4 directions buttons for providing page orientation		
OE	**Flash leds**			
		- 5W white LED		
		- very flat and homogeneous angular		

		distribution over the camera field of view		
		- true white color (large band homogeneous spectrum)		
EE				
EE	**Storage**			
		- 4 GB	- 8GB	
EE	**Microphone**			
			- 16-bit/44.1kHz audio	
EE	**Buzzer**			
		- feedback noise		
EE	**Bluetooth**			
				- used for interacting with smartphone
				- v4.0, A2DP, LE

Block Diagram

Illustrate the basic structure of the electrical solution.



Power Management

Battery technology, battery performance characteristics, rail definition, start-up sequence, max sleep current.

We have different modes of usage that could lead to different battery consumption:

- Off
- Scanning
- Scanning and Uploading
- Uploading
- Wifi connection monitoring (wake on wifi)
- Direct Setup & Update (Wifi access point)

TODO

Connectivity

Wireless technologies such as WiFi, Bluetooth, Zigbee, cellular, associated chipsets, and data rate requirements (video concerns). Connection range requirements, privacy/security of data. Wired technologies such as USB, SPI, UART, I2C, including data rate requirements.

Interfaces

Microphones, buzzers, speakers, driver sizes, frequency response, displays, touch interfaces. Consider sensors such as proximity, hall-effect, accelerometer, capacitive, ambient light, temperature. Cameras including image and video resolution, frames per second, viewing angle, image stabilization, flash/illumination, special effects.

Laser aiming

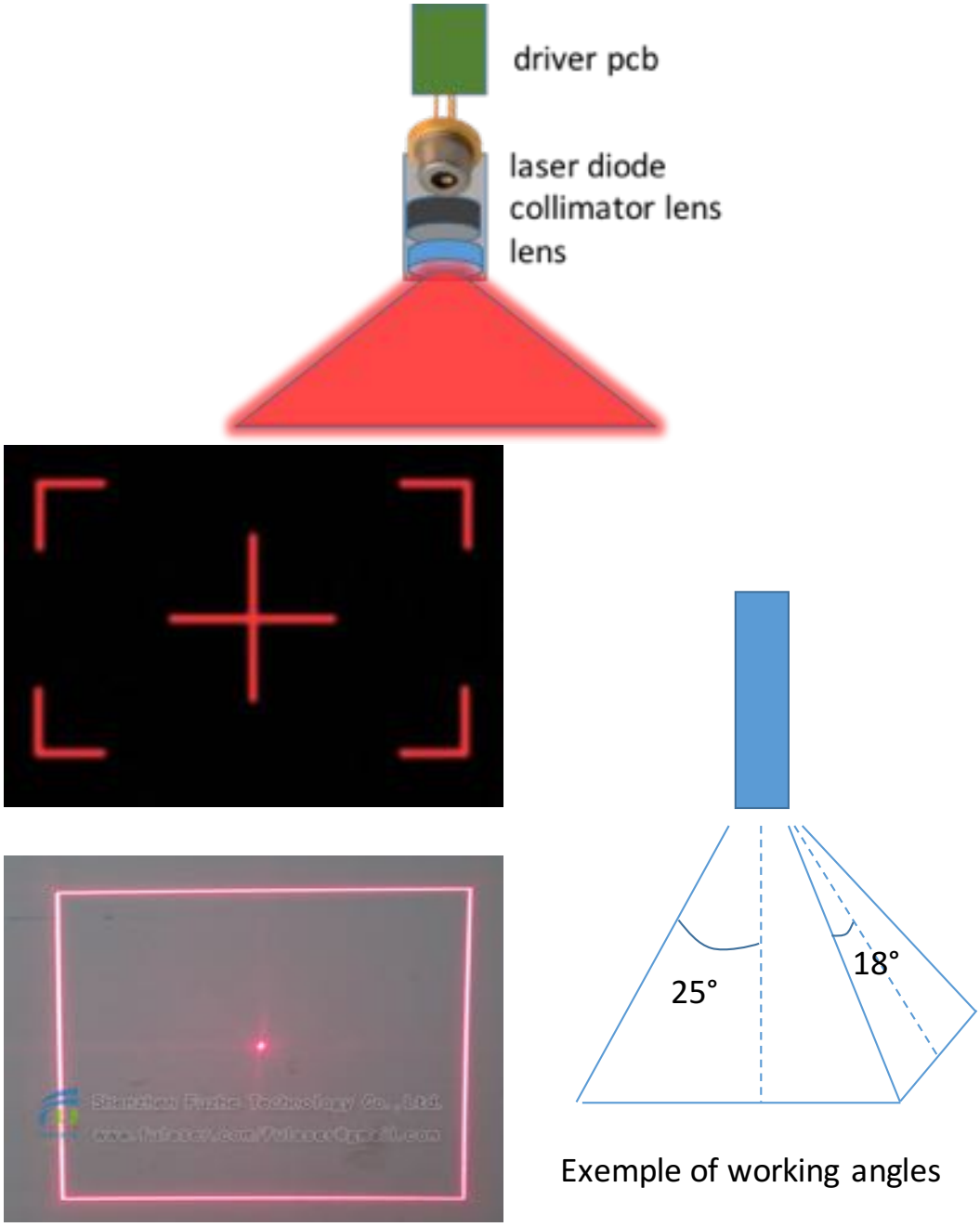
The laser system is composed of :

- A laser diode
- A collimator
- A Diffractive Lens (DOE) to generate the Rectangle Pattern

The laser system axis must me aligned with the camera axis.

The DOE is custom made according to the following specification :

- The aperture angle is 10% lower than the camera FOV
- The ratio between sides of the rectangle is $\sqrt{2}$



Exemple of working angles

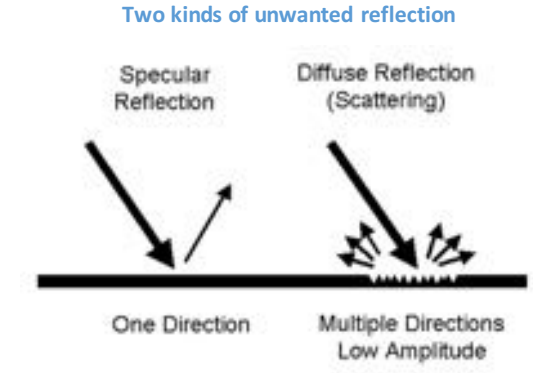
Anti-reflection

More test needed.

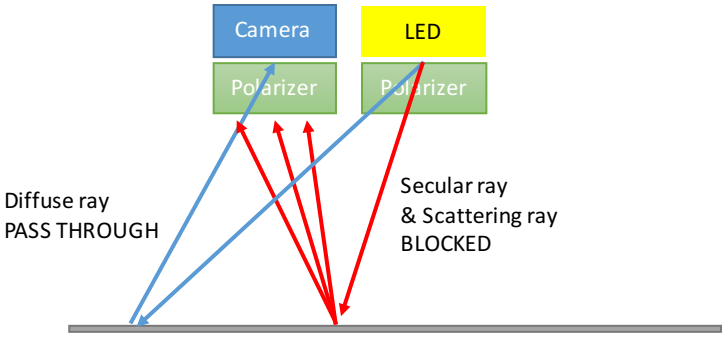
Reflection comes from :

1. Secular reflection showing a “ghost image” of the flash
2. Scattering reflection showing micro dots of the flash image

A good anti-reflection system relies on filtering reflected ligth using polarized filter on both the LED emitter and the camera sensor.



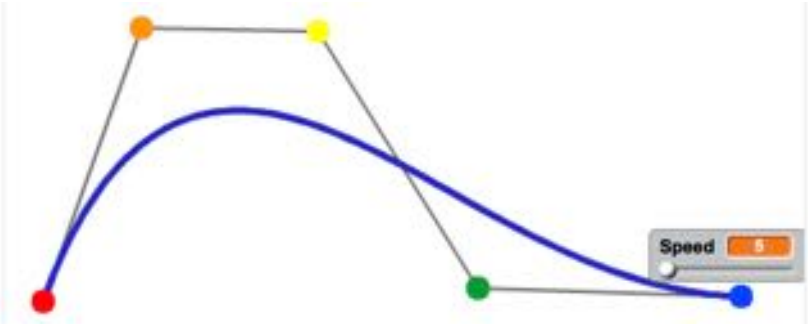
Reflection



No reflection

Curve correction

To perform this processing we need to compute a 3D model of the curved sheet of paper. The computing will be done using pure image processing.

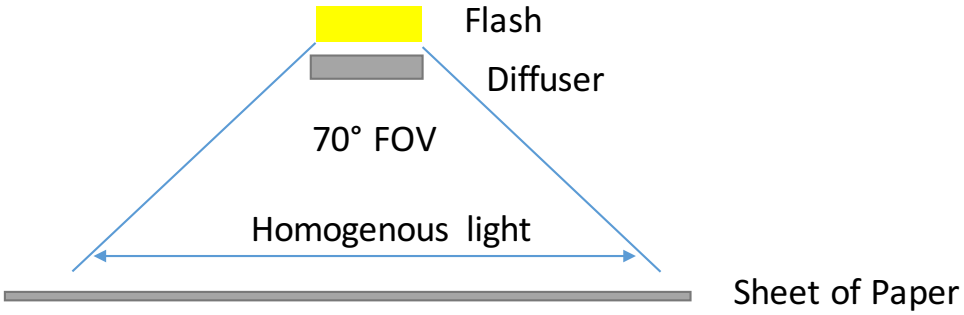


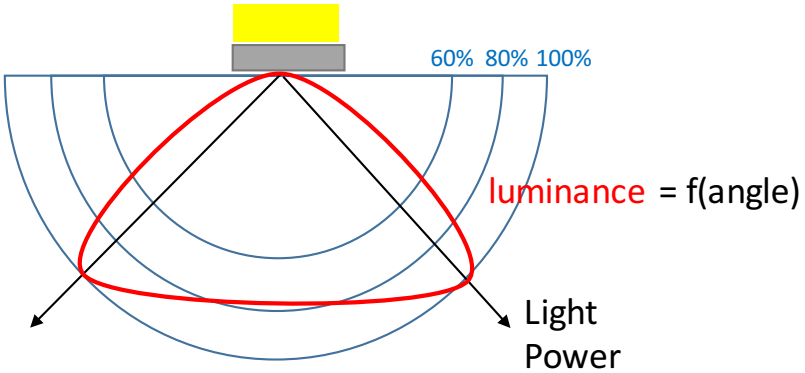
Page profile model : 4th order Bézier curve

Anti-burn lighting

Burn is a lost area on the image that appears white. It comes from the saturation of a population of pixels which has received too many photons during the exposure time. Shortening the exposure is not a solution because other pixels might need more exposure time to reveal details (if not they will look black and we face the opposite issue). Moreover, having a non-homogeneous light over the surface means having trouble when post processing the image for binary thresholding etc…

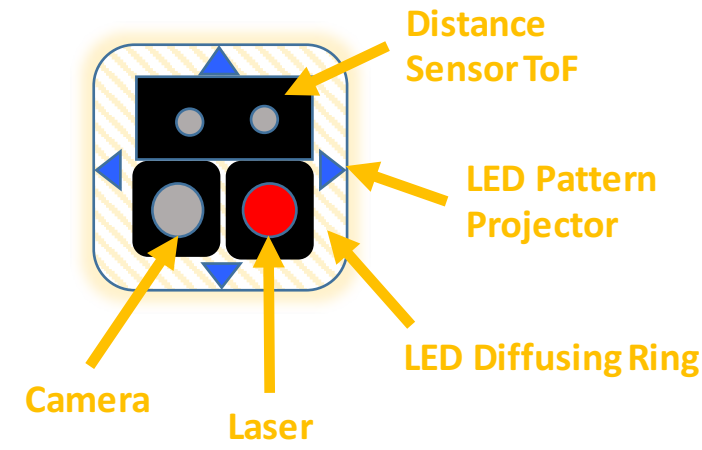
A good anti-burn system relies on having a very good diffuser in front of the LED to get an homogeneous light over the whole image area.

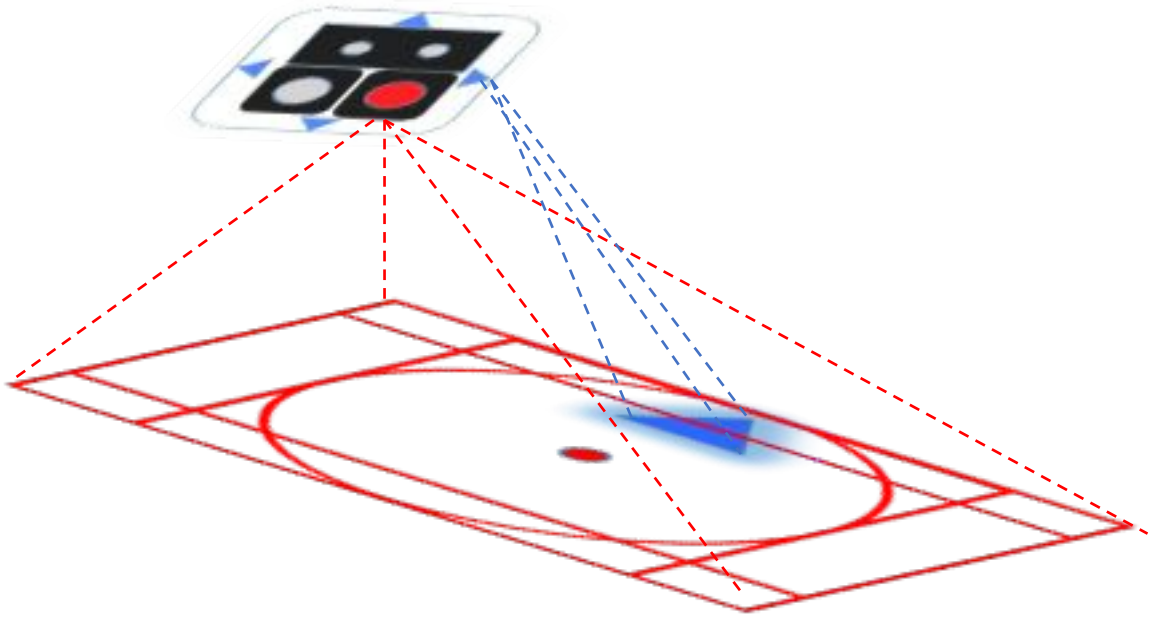




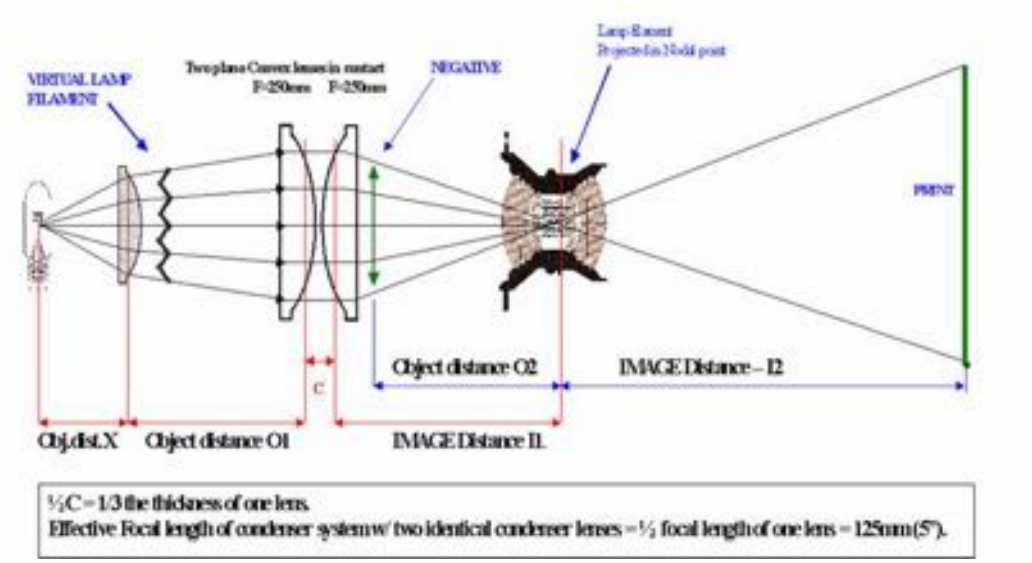
Ideal luminance distribution over the camera FOV

LED Orientation Pattern Projector





The way to do that is to use a well-known assembly of different plastic lens such as the one you find in **keychain logo projectors**.


VIRTUAL LAMP FILAMENT
Two plano-Convex lenses in contact
F=250mm F=250mm
NEGATIVE
Lamp Filament
Projected to Nodal point
PRINT
C
Object distance O2
IMAGE Distance – I2
Obj.dist.X
Object distance O1
IMAGE Distance I1
½C = 1/3 the thickness of one lens.
Effective Focal length of condenser system w/ two identical condenser lenses = ½ focal length of one lens = 125mm (5").

Actuators

NA

Solenoids, motors, pumps, valves, etc. Size, voltage, current draw, torque/speed specification, total stroke.

NA

Processing

MCU or MPU, processing "horse power", processing speed, memory considerations.

Analog

ACDC requirements, amplifiers, noise, ripple, measurement resolution and accuracy.

Firmware & Software Requirements

Describe the high level firmware requirements for the product. If specifics are not known, describe the expected or preferred behavior in every state the product can be in.

Block Diagram

Illustrate the basic structure of the firmware modules and their relationships. As an example of a layered architecture diagram:

TODO

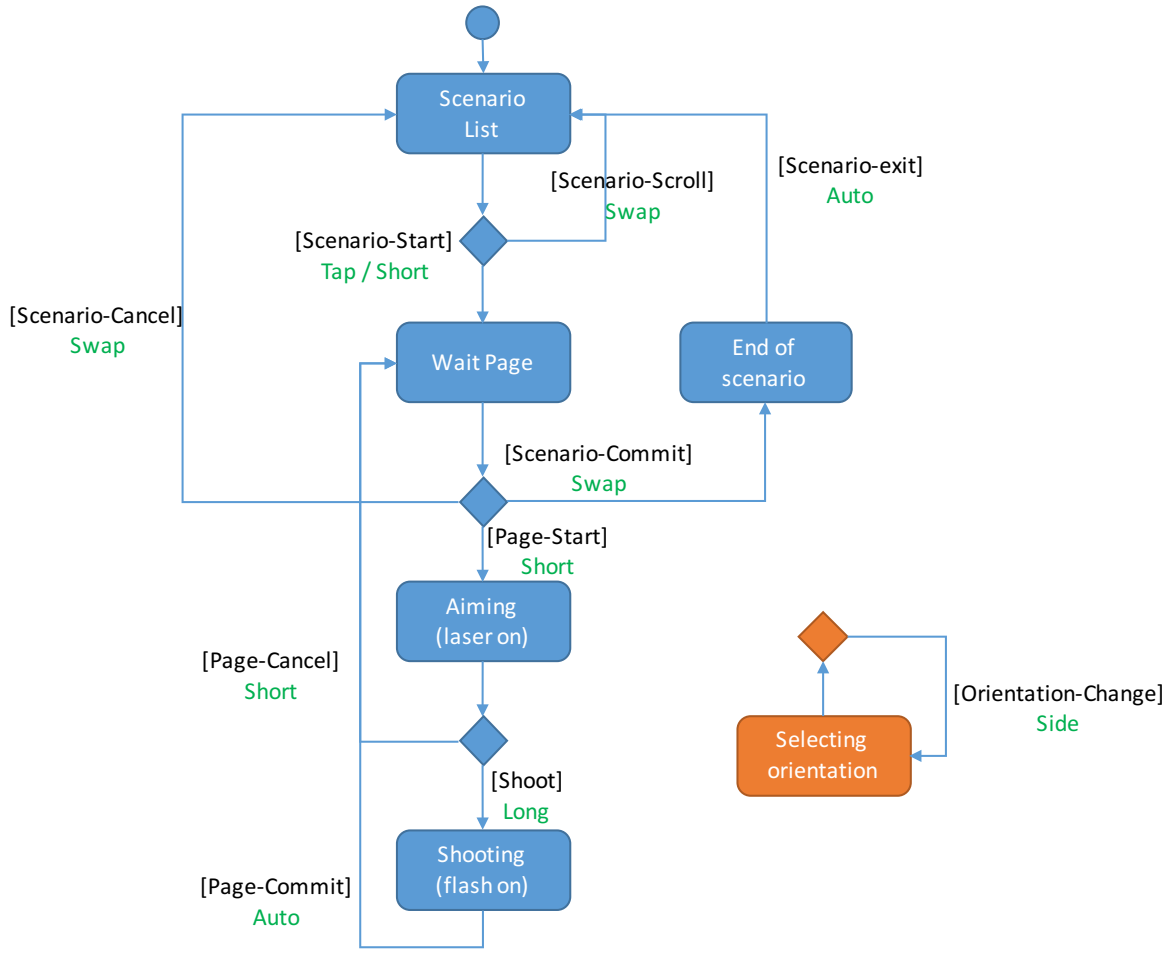
State Diagram

For each mode of operation, describe each state the firmware application will assume, as well as, the transitions between these states. For example, in normal operation mode, the following states may exist, with the possible transition criteria identified:

We have different modes of usage :

- Off
- Scanning
- Scanning and Uploading
- Uploading
- Wifi connection monitoring (wake on wifi)
- Setup (hotspot + QRCode scanning)

Capture Diagram



Real-Time Constraints

What are the timing constraints on any operations the device may need to meet? An example might be to receive a piece of data, or capture a button press, and then react by toggling a pin, within a certain time window. It is important to get an idea of all possible "hard" real-time events that must be handled simultaneously.

- QRCode reading < 1sec

For Basic installation

- Sharpness validation

For avoiding blurry image capture < 500 ms

Communications

Identify any communications busses to be used within the device, or interfacing to other devices, and their anticipated maximum bandwidth. If this device will communicate with other machines (such as another processor), describe the application-layer protocol.

Data Storage

What data will the firmware be required to maintain over resets (non-volatile memory)? What (non-implementation) application data is required to be maintained during runtime?

Security or Safety-Critical Applications

Are there any security-related or safety-critical functions that the firmware application will be responsible for?

Coding Standards & Algorithms

Will the code base be required to adhere to any specification? If so, list them. Are there any mathematical algorithms, which must be developed, or any existing algorithms, which must be implemented?

Certifications

Must the development process or output firmware image be subject to any certification processes?

Loading & Upgradability

How is the firmware loaded and tested on the production line? Is the user expected to update the revisions in the software? How will he/she do it?

Mechanical Performance Requirements

List all known performance requirements for the product including all general reliability test points as well as any tests unique to the product's feature set. Be sure to include information on test conditions if applicable.

Drop Performance

State the criterion for success with as much specificity as possible.

Overall Product Cycle Life

State the criterion for success with as much specificity as possible.

Wear Out For Specific Features

State the criterion for success with as much specificity as possible.

Crush Resistance, Sit Test

State the criterion for success with as much specificity as possible.

Temperature & Humidity Exposure

State the criterion for success with as much specificity as possible. Be sure to include limits on temperature exposure for both storage and operating conditions.

Ultraviolet Light Exposure

State the criterion for success with as much specificity as possible. Be sure to include both mechanical and cosmetic stability.

Water Ingress Protection Rating

State the criterion for success with as much specificity as possible.7.8 Scratch Resistance, Tumble Test

State the criterion for success with as much specificity as possible.

Vibration Test

State the criterion for success with as much specificity as possible.

Chemical Resistance Test

State the criterion for success with as much specificity as possible.

Skin Compatibility

State the criterion for success with as much specificity as possible.

Manufacturing Requirements

Define the manufacturing processes for the major parts, and the basic assembly method to build the product. If possible, describe all tools, special machines, post ops, and time-intensive assembly steps. Also include any manufacturing steps with outputs that must be confirmed 100% of the time due to criticality.

Packaging Requirements

Describe the packaging design in general terms (single retail, multipack shipper, kitting options, slider box, clamshell, etc). Include any information on materials (recyclable?), design for impact resistance, tamper-proof features, instruction manuals, quick start guides, and unique user interaction touch points.

Wall charger is not provided.

Part	File
Main box	
Device	
USB charging cable	

Packaging Design Concept

Include a reference image of the packaging concept. This can be a rendering or a picture of an existing packaging solution.

Accessories

Describe any additional components required in the packaging solution including charging accessories, cleaning cloths, protective wrappers, or dual purpose packaging.

Graphics, Artwork, & Decals

Include any graphics, artwork, labels, or decals that is associated with the packaging solution. These can be placeholders for now.

Testing Requirements & Shipping Conditions

List any known testing requirements for the product packaging. Include requirements on shelf life expectations (product expiration date).

TODO

The product should fulfil the drop test according to the following instruction:

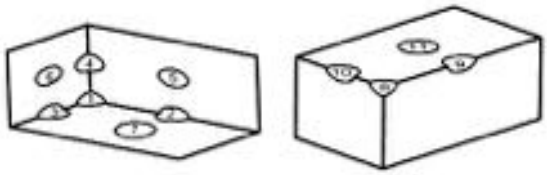
Drop Test

Drop test will be made for a master carton packaging. The procedure says to drop for 11 times from on a unbending horizontal surface as following:

WEIGHT	HEIGHT
< 10 Kg	800 mm
10 to 20 Kg	600 mm
20 to 30 Kg	500 mm

1.- On bottom corner of the packaging.
2.- On next largest edge.
3.- On next shortest edge.
4.- On next vertical corner.
5.- On next lateral surface.
6.- On frontal surface.
7.- On bottom surface.
8.- On a corner from the top side.
9.- On next largest edge of the top side.
10.- On the next shortest edge from the top side.
11.- On the top side surface.

See drawing annex.



At the end of the test no broken, scratches, damages, disgust, etc. will appear on the appliance (including screws, etc.. loose). The appliance operation must not be affected.

Ancillary Hardware & Software Compatibility

List any existing products or software that the product must be compatible with including cables, stands, phones, tablets, tools, applications, and protocols.

TODO

Regulatory and Certification Requirements

EU, US, Japan, Chinese STANDARD should be fulfilled

Laser Eye Safety Label

TODO

Sales & Distribution Requirements

Sales avenues - big box retail, on line, direct, B2B, etc. Where will this be sold, and what regulations will be applicable for that region.

Maintenance, Serviceability, Calibration, & Warranty

RMA, call center, hot line, web site, product support. What happens when a consumer has a bad product? Return policies, design for serviceability. What happens at the end of its useful life?

Dismounting

Product shall be designed to allow for dismounting without damaging the dismounted parts.

Out of Scope

List any technologies, design solutions, or manufacturing concepts that should not be considered for the final product solution.

Appendix

Include any component specifications, artwork, schematics, or other reference material associated with the product.