MAMBO

Identification of hair color using a hair color data base

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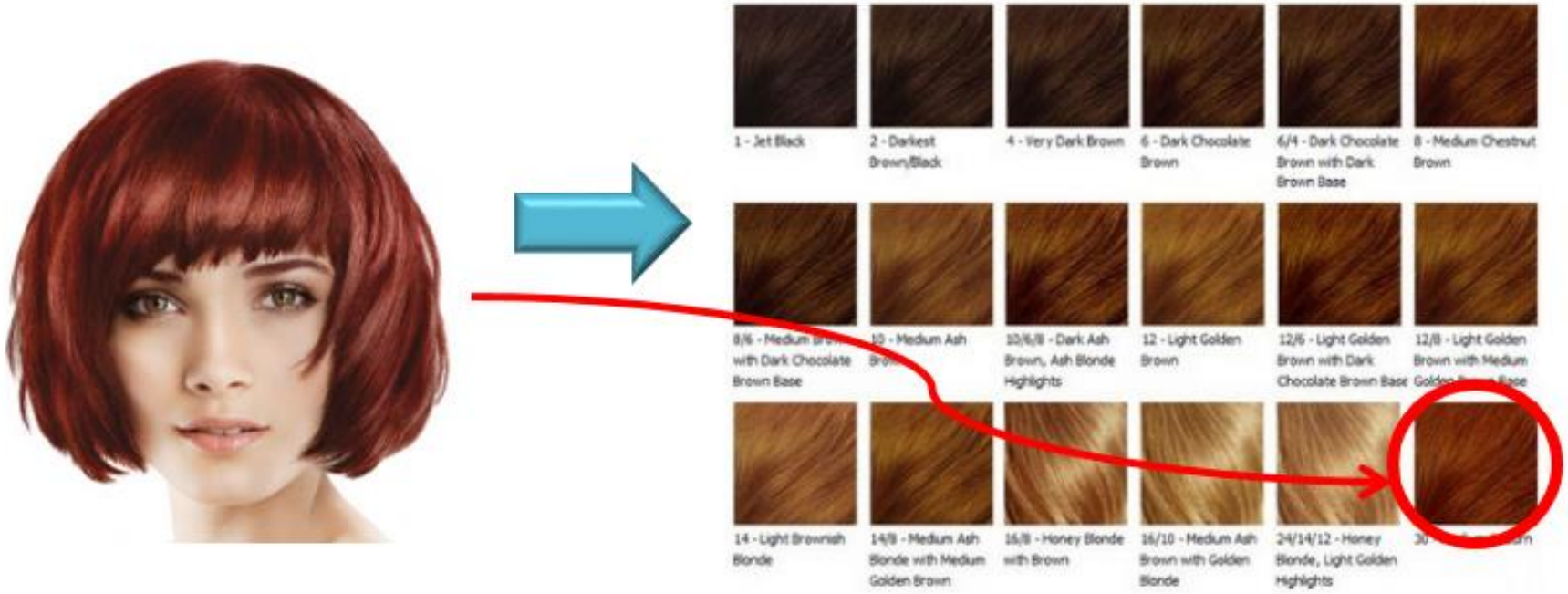
Introduction

Problematic : Need of a reliable system for hair color assessment and identification

Background: Professional colorists do not measure hair color in a standardized manner i.e. with L,a,b value and CIELAB references but compare it to a hair color catalogue (database).



Idea

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Design a sensor that delivers hair color information to help professional colorist identify hair color (in-vivo and in-vitro)

+

Design a sensor mimicking expert professional colorist.

The MAMBO sensor

MAMBO

- Turnkey system
- All adjustment are automatic
- Measurement is instantaneous
- In vitro or in vivo

Connection to PC

Electronics

Imaging sensor

Hardware design : Imaging sensor

ILLUMINATION

White LED
+
Diffusive sphere

Uniform illumination

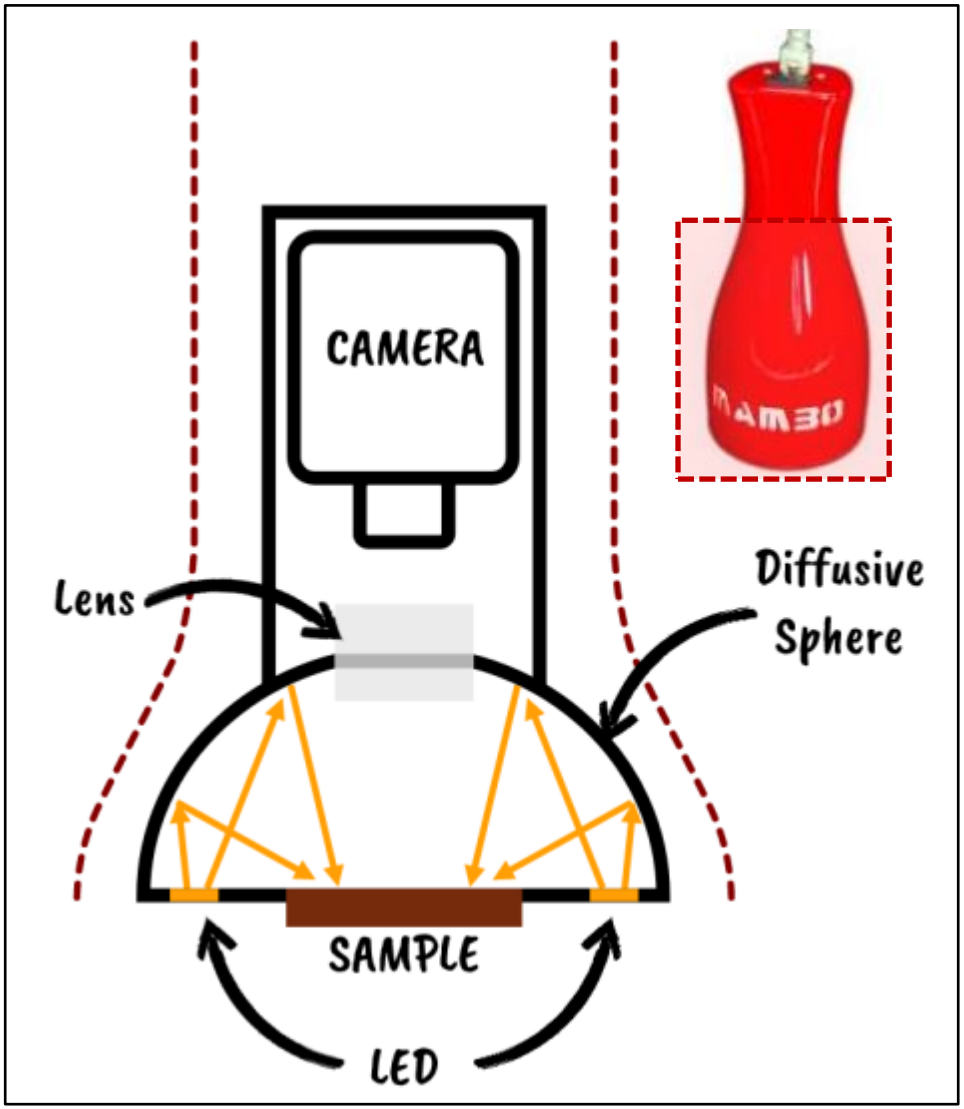
ACQUISITION

Color Camera
(12 bits)
+
Objective/Lens

Accurate visual rendition

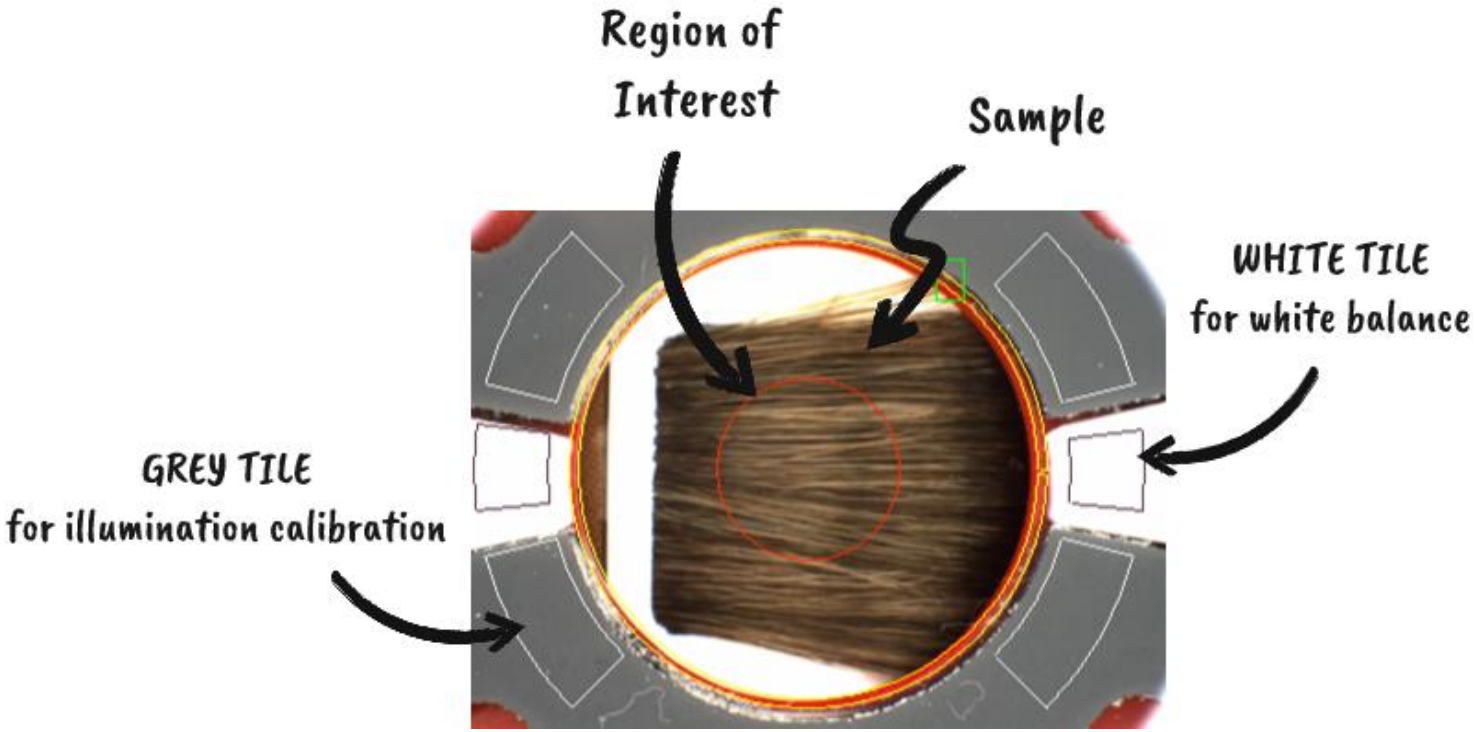
+

Ethernet connection to PC



Hardware design : Calibration

Calibration tile are present in the field of view to maintain a stable illumination and white balance



Full image

Software design : Color Matching

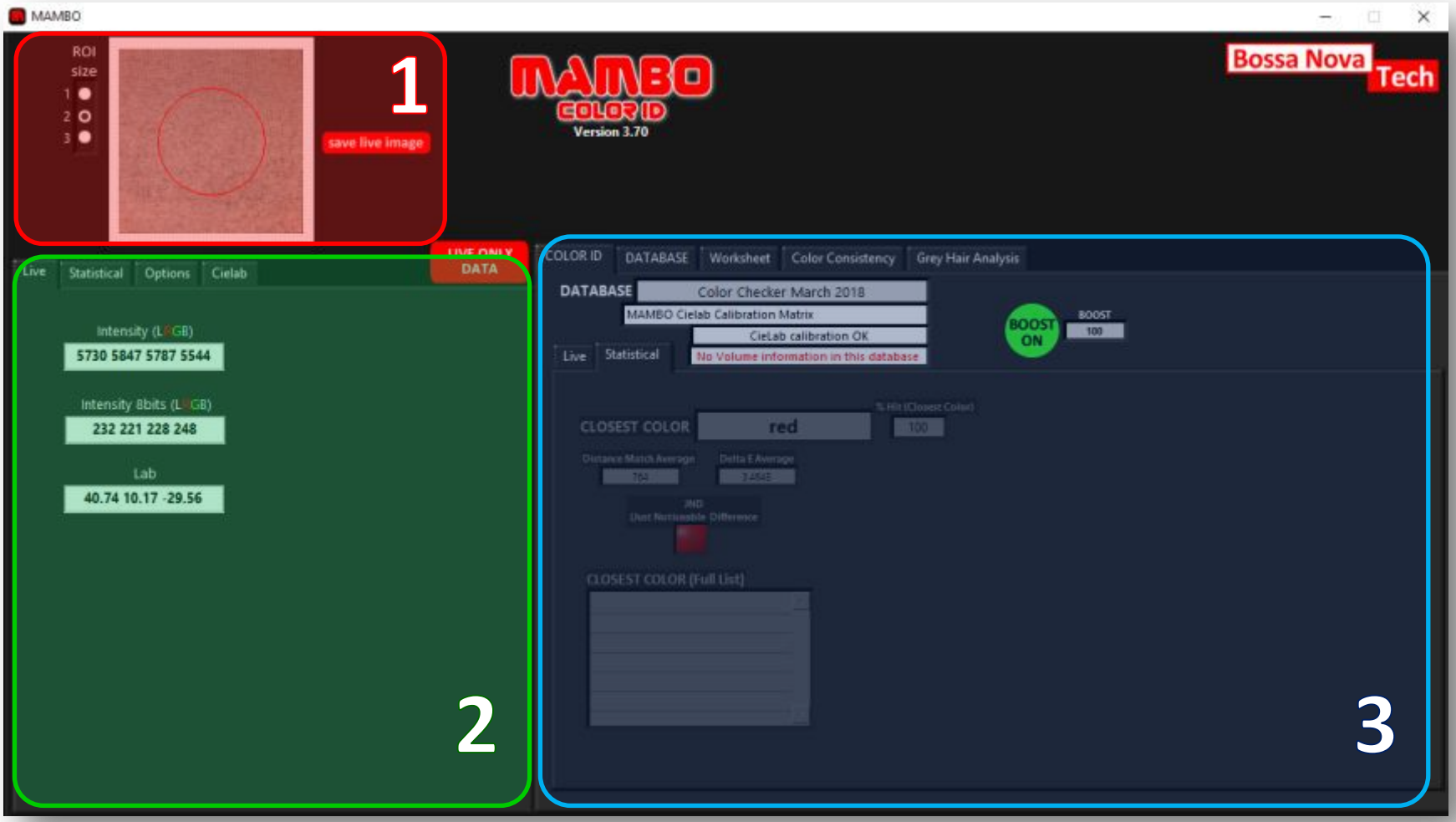
Basic algorithm : The software collects the **RGB** value from the color camera for each sample and calculates the distance from all the DATABASE element

$$\textbf{Distance} = \sqrt{(\mathbf{R} - \mathbf{R}_{\text{database}})^2 + (\mathbf{G} - \mathbf{G}_{\text{database}})^2 + (\mathbf{B} - \mathbf{B}_{\text{database}})^2}$$

The **minimum Distance** identifies the closest color.

Note that if the database is only composed of RED color, a GREEN sample will still find the closest color.

Software design : Interface - General

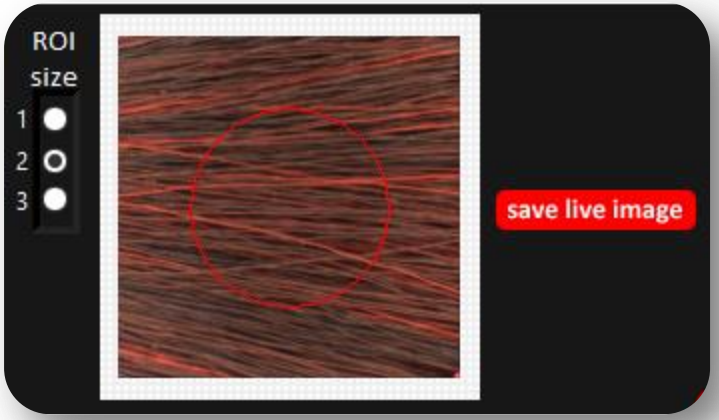


1 : Live Image / 2 : Measurement / 3: Analysis

Software design : Interface - Live Image

LIVE IMAGE

- Direct visualization of your sample
- Select the size of the Region of Interest (ROI) for the analysis
- Auto-exposure feature for accurate real-time color analysis

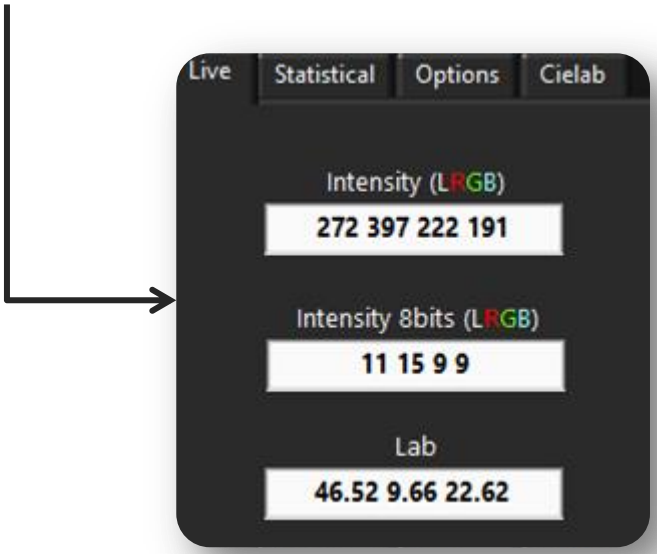


ROI	Diameter	Area
1	4.5 mm (~ 3/16 “)	16 mm^2 (0.024 square inch)
2	6.5 mm (~ 1/4”)	33 mm^2 (0.05 square inch)
3	10 mm (~ 25/64”)	78 mm^2 (0.12 square inch)

Software design : Interface - Live Data

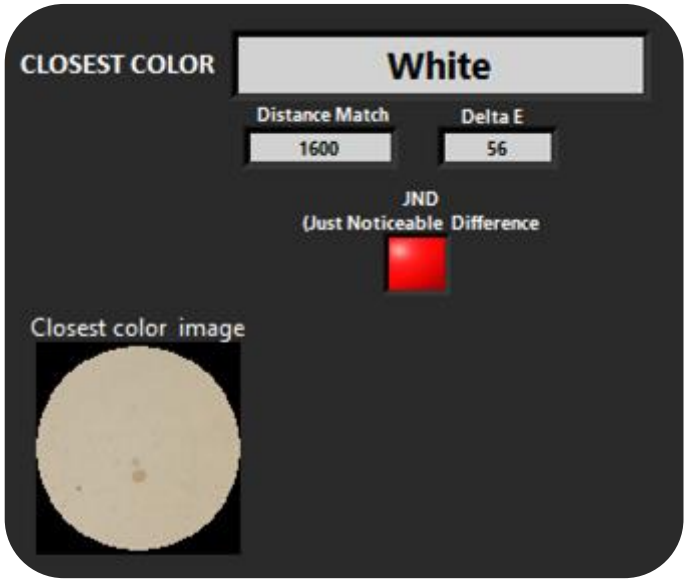
LIVE IMAGE Measurement

- Real-time LRGB (Luminance, Red, Green, Blue) and L*a*b Values



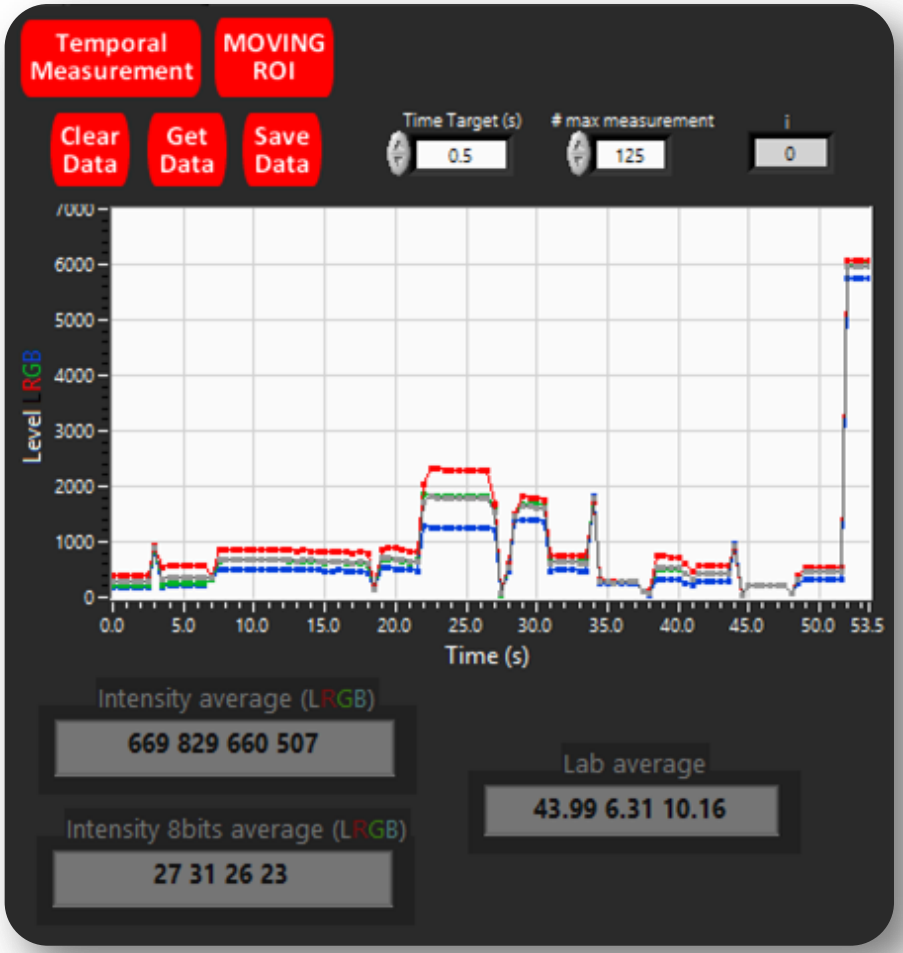
- Display the closest color that matches the color of the sample in the selected database

- Distance from the match and determination of the $\Delta E^*_{a,b}$: if < 2.3, the color difference is not humanly noticeable

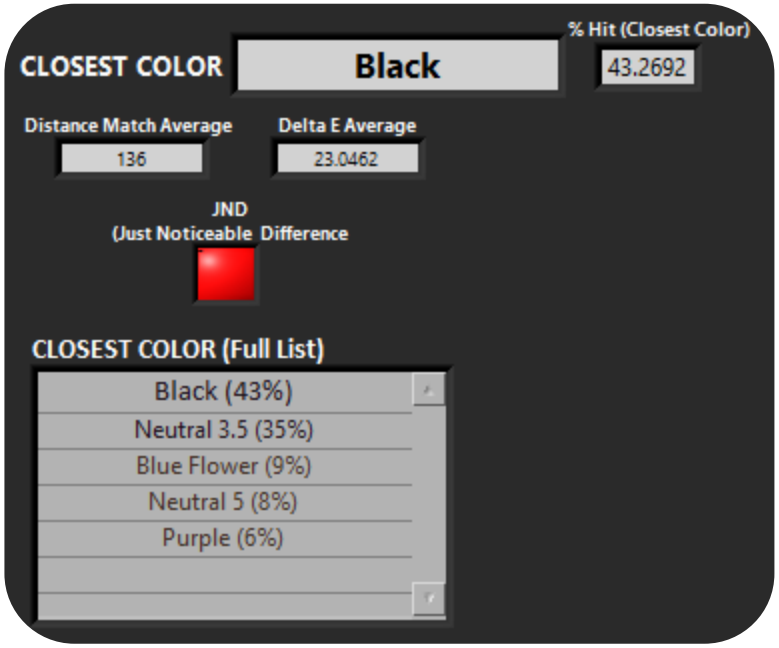


Software design : Interface - Statistical Data

LIVE IMAGE Statistics



- Temporal evolution of live color parameters
- Adjustable parameters of the measure
- Distance from the match on average and on the full evolution



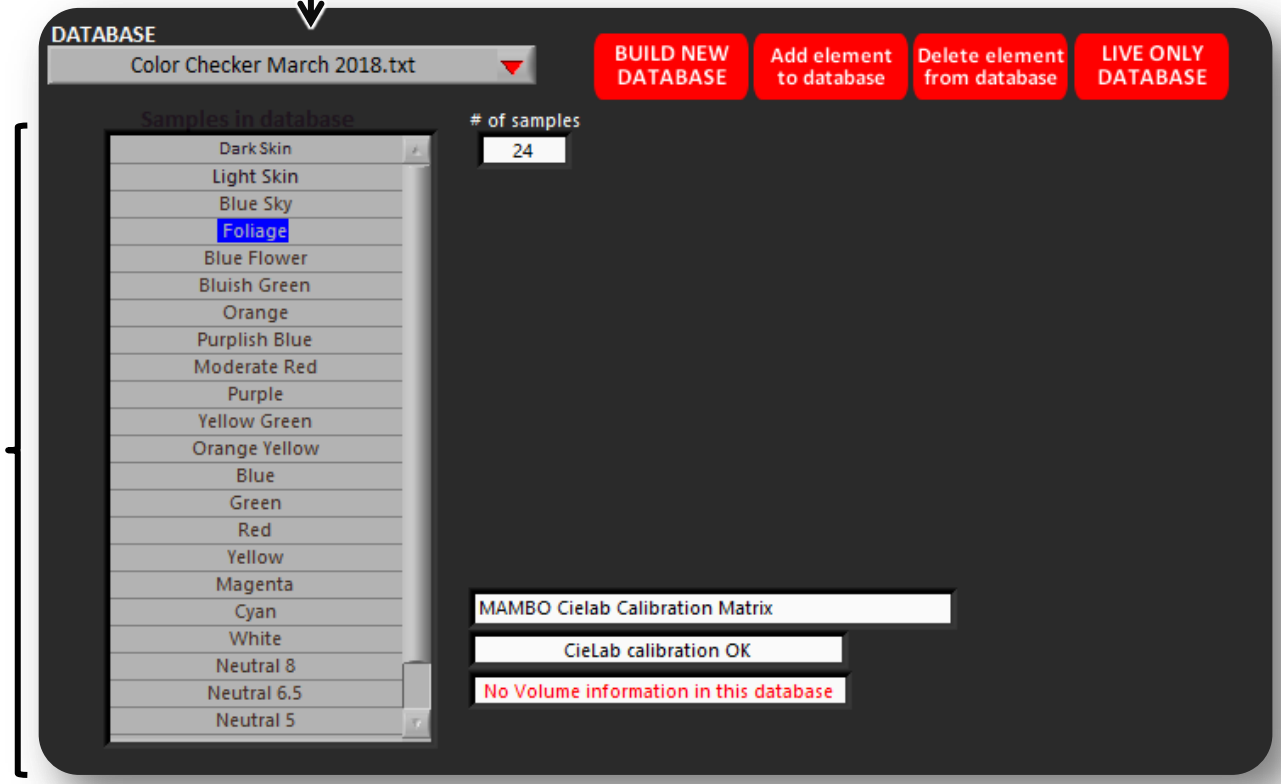
Software design : Interface - Database

DATABASE Tab

Select the database you want to use for your analysis

Add / modify / delete the selected database or its elements

Color elements of your database



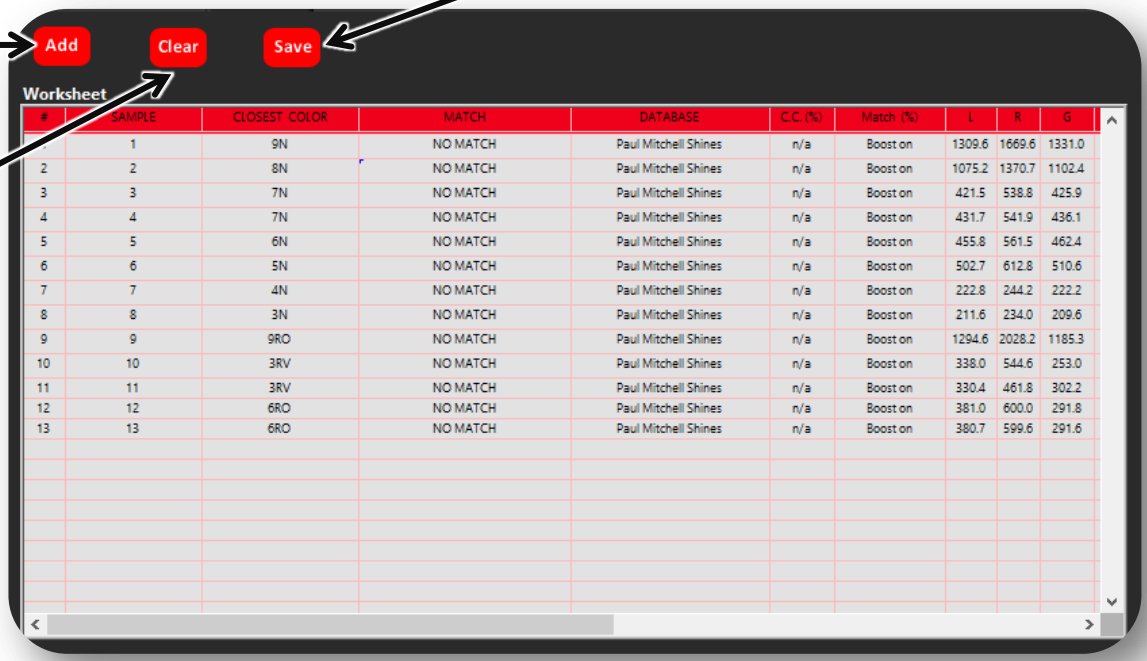
Software design : Interface - Worksheet

WORKSHEET Tab

Add live measurement to worksheet

Clear worksheet

Save worksheet as text file



#	SAMPLE	CLOSEST COLOR	MATCH	DATABASE	C.C. (%)	Match (%)	L	R	G
	1	9N	NO MATCH	Paul Mitchell Shines	n/a	Boost on	1309.6	1669.6	1331.0
2	2	8N	NO MATCH	Paul Mitchell Shines	n/a	Boost on	1075.2	1370.7	1102.4
3	3	7N	NO MATCH	Paul Mitchell Shines	n/a	Boost on	421.5	538.8	425.9
4	4	7N	NO MATCH	Paul Mitchell Shines	n/a	Boost on	431.7	541.9	436.1
5	5	6N	NO MATCH	Paul Mitchell Shines	n/a	Boost on	455.8	561.5	462.4
6	6	5N	NO MATCH	Paul Mitchell Shines	n/a	Boost on	502.7	612.8	510.6
7	7	4N	NO MATCH	Paul Mitchell Shines	n/a	Boost on	222.8	244.2	222.2
8	8	3N	NO MATCH	Paul Mitchell Shines	n/a	Boost on	211.6	234.0	209.6
9	9	9RO	NO MATCH	Paul Mitchell Shines	n/a	Boost on	1294.6	2028.2	1185.3
10	10	3RV	NO MATCH	Paul Mitchell Shines	n/a	Boost on	338.0	544.6	253.0
11	11	3RV	NO MATCH	Paul Mitchell Shines	n/a	Boost on	330.4	461.8	302.2
12	12	6RO	NO MATCH	Paul Mitchell Shines	n/a	Boost on	381.0	600.0	291.8
13	13	6RO	NO MATCH	Paul Mitchell Shines	n/a	Boost on	380.7	599.6	291.6

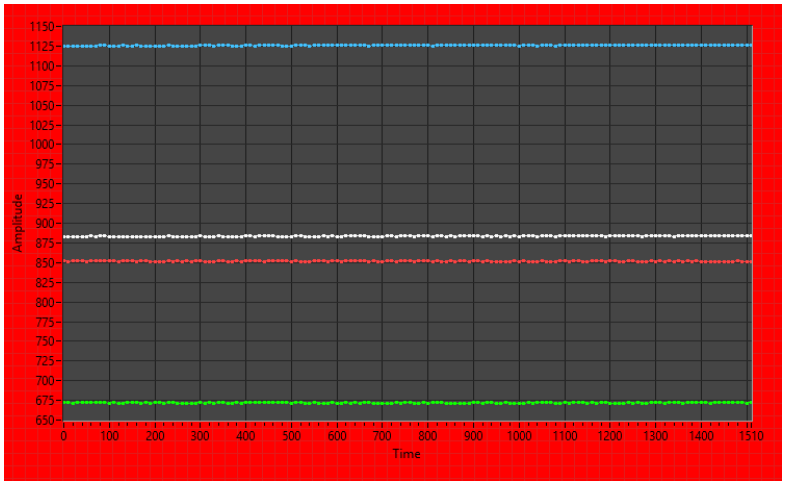
Gloss influence / Accuracy / Stability

Using a transparent slide with a glossy side and a matte side, we proceed to a measurement on a color checker to compare the influence of the gloss.

The experimental results are similar as the identified color is not modified whether the side is glossy or matte.

We can conclude that the gloss has no effect on the color identification.

There has been no noticeable increase or decrease in results over long period of time :



RGB color values of a sample over a 24-hour period

1 measure every minute

Examples of applications

Color identification

Database comparison

Color consistency

Color identification

How difficult it is to identify Hair color ?

Color Matching performance

Optical scientists 46%

Professional colorists 50%

MAMBO 95%

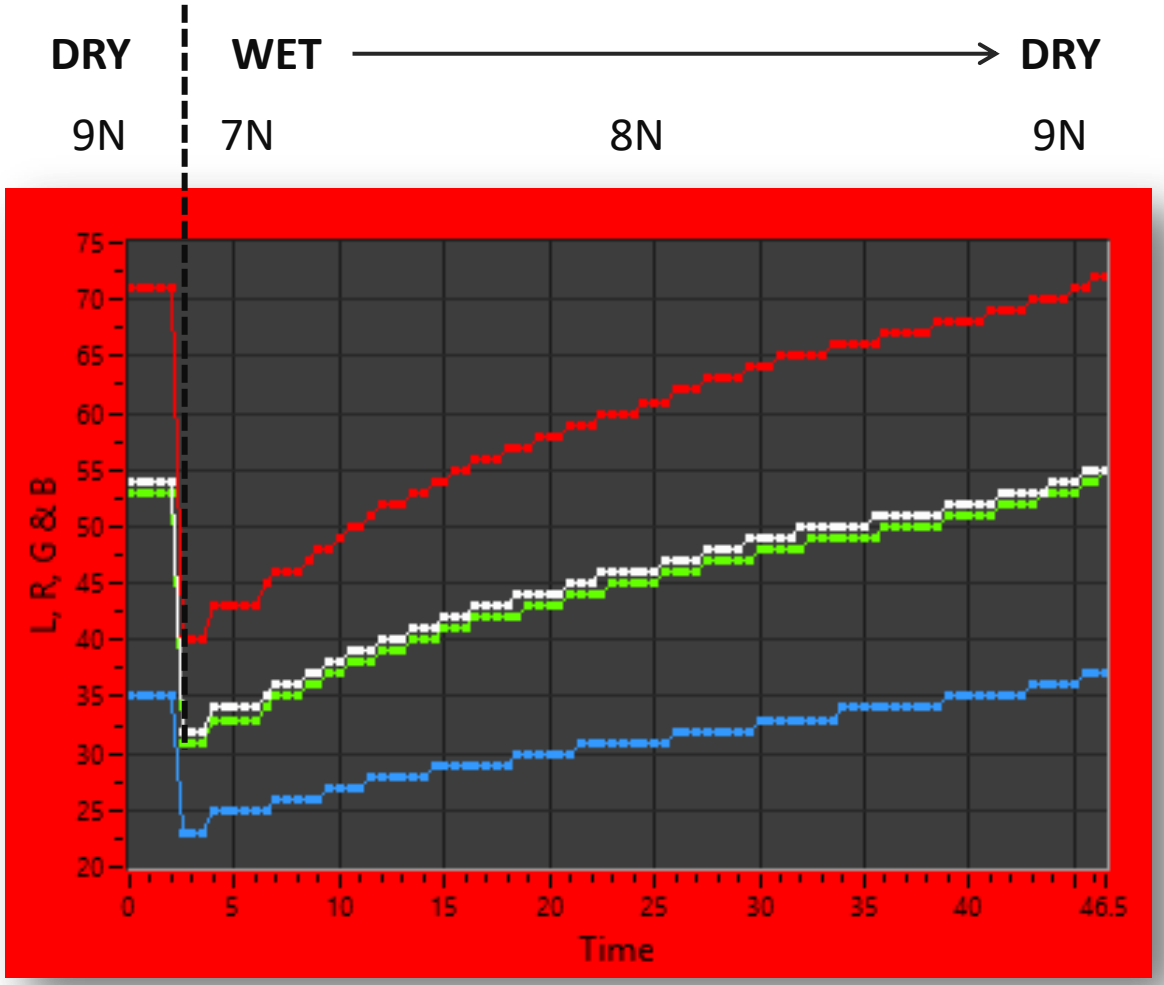
** results based on a **50 samples study** using Paul Mitchel swatch book*
***7 optical scientists** and **8 professional colorists** took part in the study*

***Note that the sensor does not need to have the swatch book to compare as the database is already in the system.*

Color identification : WET to DRY

Dry Hair: 9N
Wet Hair: 7N

WET: Lost 2 levels.
Monitoring hair drying:
After 25 mn, 8 N.
After 45 mn, back to 9N

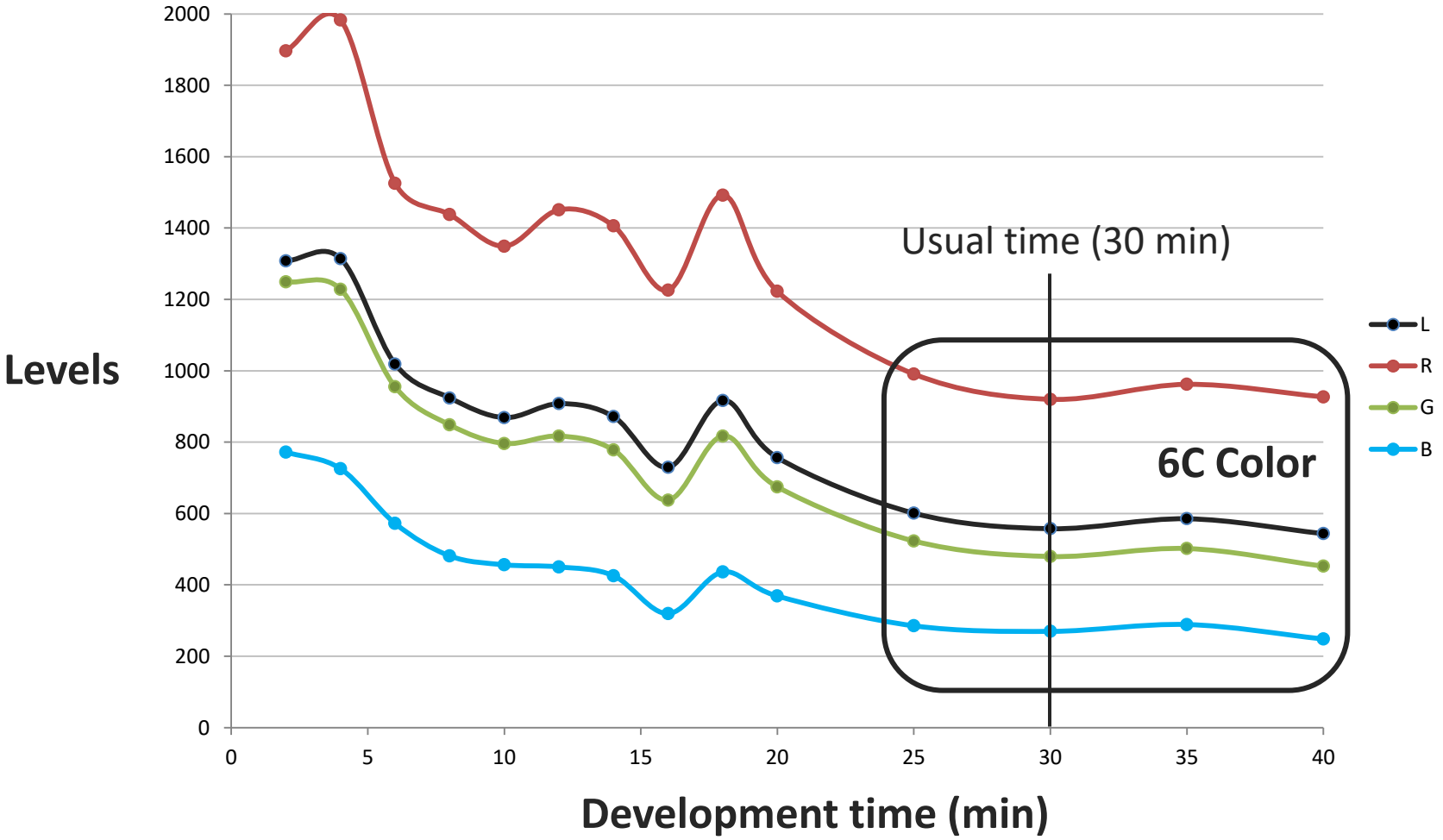


Database comparison

Compare 2 lines of product from different brands

- 2 Database are created for 2 products lines.
- Elements from DATABASE #1 are matched to the ones of DATABASE #2.

Color Consistency : Variation of color vs development time



Minimum development time in critical in the deposition process
if we want to obtain the right color

Color Consistency : Variation of color vs time (degradation)

For quality control, the master perm swatch test is made on the first of the month. Perm swatches are made everyday, comparing themselves to that month's master swatch test.

REFERENCE 08/04/2015	08/05/2015	08/06/2015	08/07/2015
10a, Ash	10a, Ash	10a, Ash	10a, Ash
Golden, Copper	Golden, Copper	Golden, Copper	Golden, Copper
Mahogany, Red	Mahogany, Red	Mahogany, Red	Mahogany, Red
Yellow, Blue, Clear	Yellow, Blue, Clear	Yellow, Blue, Clear	Yellow, Blue, Clear
2e	2e	2e	2e
4d	4d	4d	4d
6c	6c	6c	6c
8b	8b	8b	8b

In **RED**, the swatches with color issue.

A criteria is defined: the distance compared to the reference.
This allows a control of the color quality over time.

Conclusion

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- Objective tool for accurate color identification
- No effect from gloss
- Easy to use
- In-vivo and in-vitro
- Useful tool for the laboratory or the salon

Applications :

- Can help formulation and color deposition
- Prediction of colors mix
- Creation of color databases and references
- Monitoring of coloration degradation