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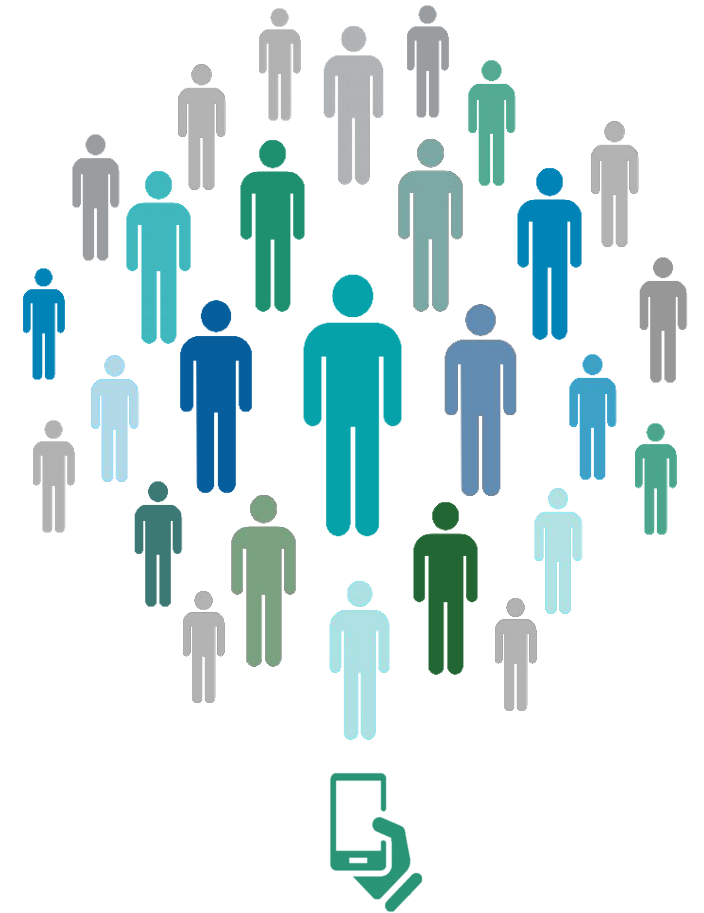
# CrowdColor

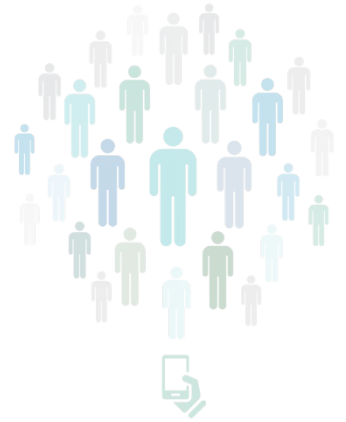
## Crowdsourcing Color Perceptions using Mobile Devices

Jaejeung Kim<sup>1</sup>, Sergey Leksikov<sup>1</sup>, Punyotai Thamjamrassri<sup>2</sup>,  
Uichin Lee<sup>1</sup>, Hyeon-Jeong Suk<sup>2</sup>

<sup>1</sup> Dept. Knowledge Service Engineering

<sup>2</sup> Dept. Industrial Design





# Overview

**Motivation**

**Related Work**

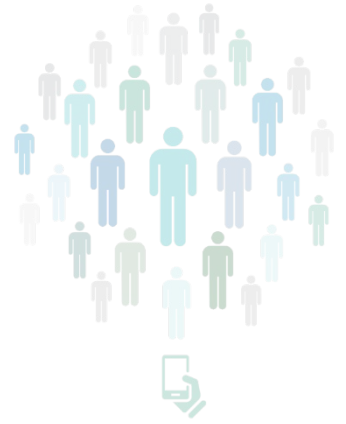
**CrowdColor Design**

**Experiment 1: CrowdColor Generation**

**Experiment 2: CrowdColor User Evaluation**

**Limitations**

**Conclusion & Future Work**



# Motivation

**Color is a primary purchase criterion in fashion.**

**Inaccurate colors leads to negative shopping experiences (Parker *et al.* 2009).**

# Motivation



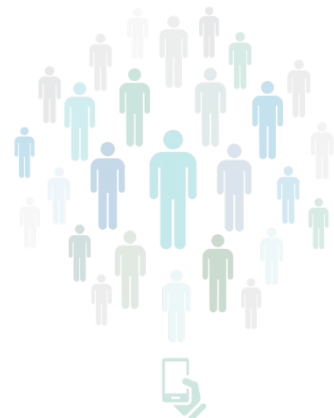
**Expectation**



**VS**

**Reality**





# Motivation

Customer reviews are a key source of subjective opinions of the product. However it is not easy to convey precise meaning of color.



Roll over image to zoom in

Next Level

Next Level Men's Polo Shirt. 6420

★★★★☆ 28 customer reviews

Price: \$7.75 - \$38.39

Sale: Lower price available on select options

Size:

Select Size Chart | Fit: As expected (70%)

Color: Cardinal

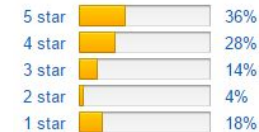


- Cotton
- Preshrunk 60% combed cotton/40% polyester.
- Lightweight
- Classic fit
- Two-button placket
- Flat-knit rib collar and cuffs

## Customer Reviews

★★★★☆ 28

3.6 out of 5 stars



Share your thoughts with other customers

Write a customer review

See all 28 customer reviews

## Most Helpful Customer Reviews

9 of 9 people found the following review helpful

★★★★★ These are winners!

By Brian Kidwell on May 6, 2013

These fit just right. Basically identical to their t-shirts. I'm 6'2", 190 lb and a large is just right for me. You won't look like a hipster, and you won't look like a little kid who is wearing his dad's shirt. The arm holes are cut slightly higher than a lot of polos, so that when you move your arm, the shirt doesn't get tugged along. The sleeve length itself comes down to mid-arm, again, slightly longer than a lot of polos; I actually like the extra inch or so of sleeve length.

tl;dr if you're looking for a slimmer polo shirt, but don't want to look like a dudebro, buy this, you'll like it.

1 Comment | Was this review helpful to you?

4 of 4 people found the following review helpful

★★★★☆ Pretty good fit ...except for the big neck opening.

# Motivation

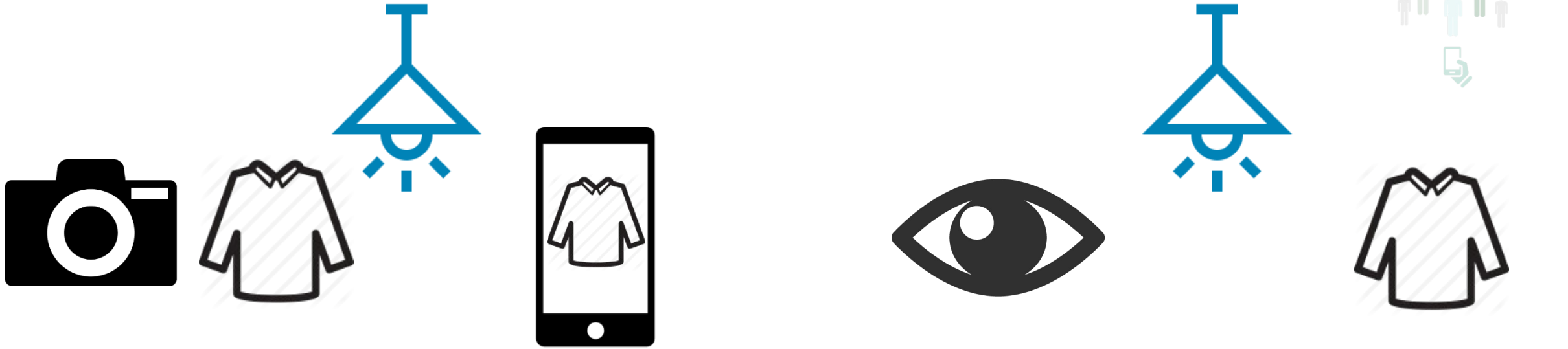


Image generation

- Capturing HW/SW
- Lighting conditions
- Manual editing

Image rendering

- Display HW
- Rendering SW

Image viewing

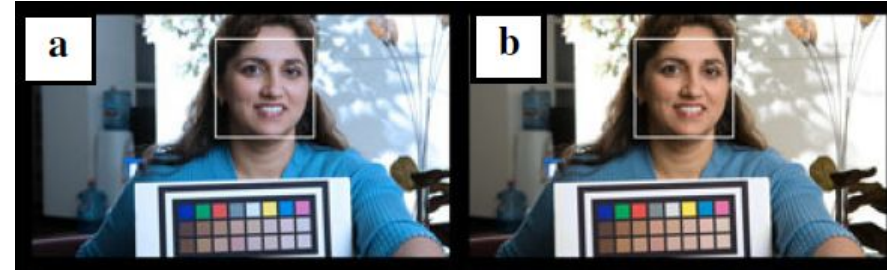
Product viewing



# Related Work

## Color Reproduction:

- Automatic white balancing
- Display adaptive tone mapping (ACM TOG'08)
- Color Match (MobileHCI'08)



Color Match (MobileHCI'08)

Image generation

Image rendering

Image viewing

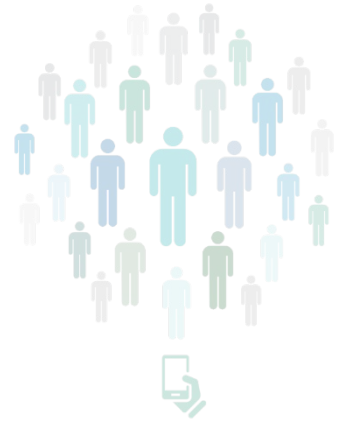
Product viewing



Color theme extraction (CHI'13)

## Crowdsourcing Graphical Perceptions:

- Visualization judgement task (CHI'10)
- Extracting color themes from images (CHI'13)



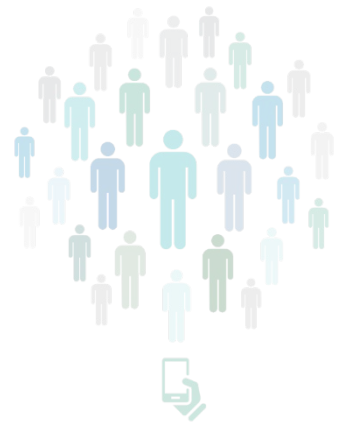
# CrowdColor Design

We aim to design and evaluate a color generation application that

- 1) **Receives explicit color inputs using a color picker**
- 2) **Aggregating the inputs into a color that can represent the product (CrowdColor)**

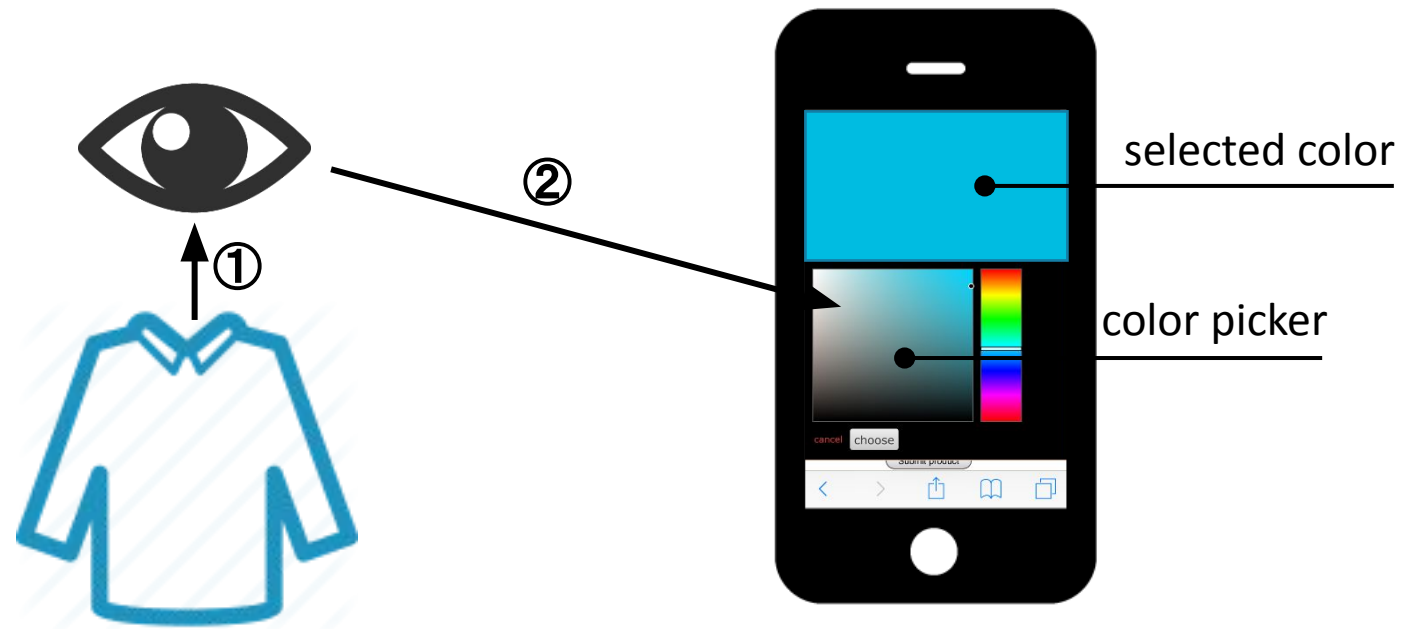
in a form of a customer review.





# CrowdColor Design

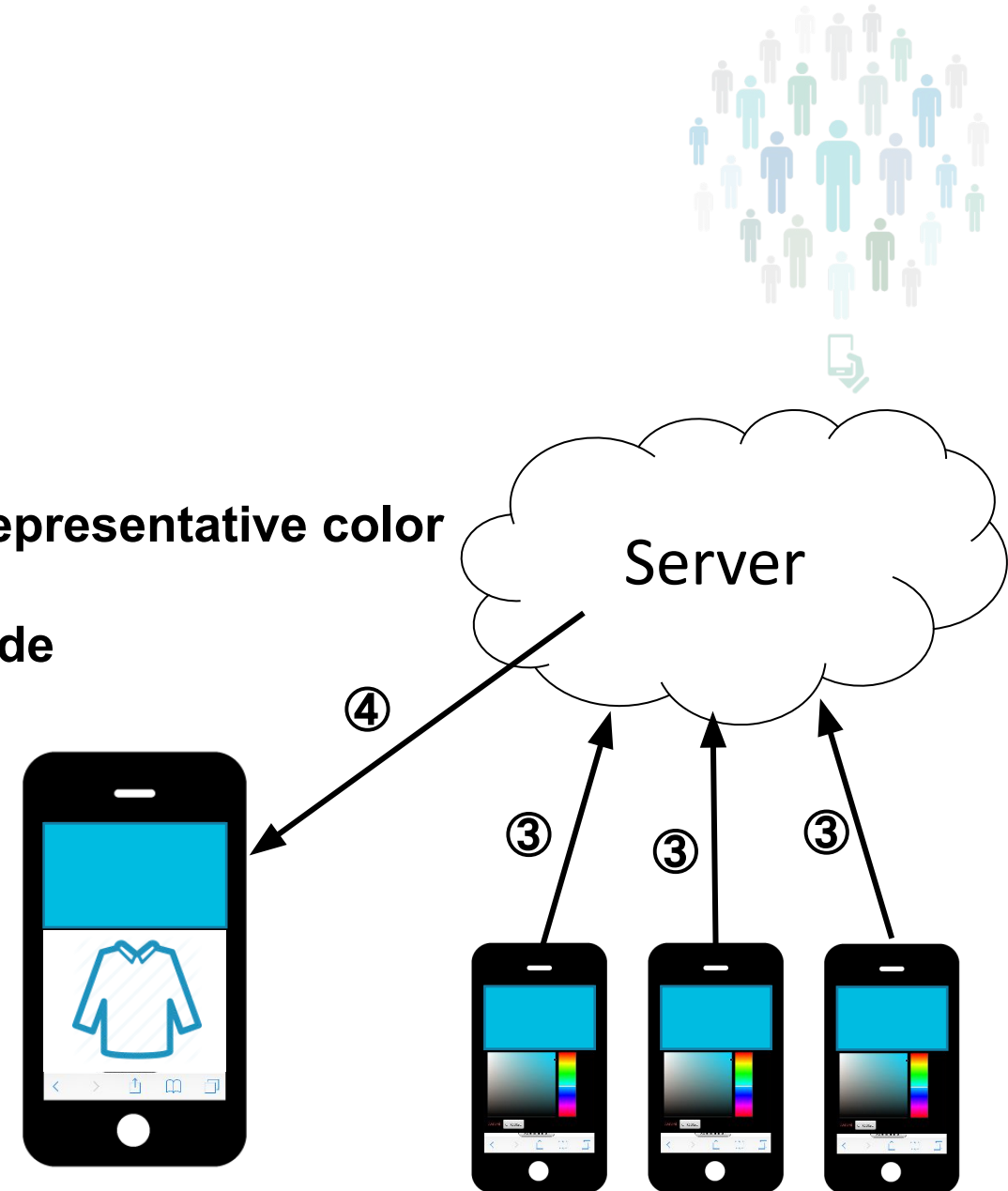
- 1) The customer perceives the color of the product
- 2) Selects the perceived color using the color picker

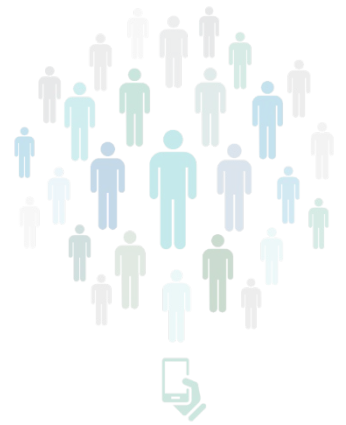


# CrowdColor Design

- 3) Selected colors are sent to the server
- 4) Server aggregates the RGB data inputs into a representative color
- 5) Device/light adaptive aggregation\* could be made

\*Color input from only a certain device under certain lighting condition will be aggregated to be given to a customer with the same environmental conditions. (e.g. iphone user under a fluorescent light will be given the aggregated colors from iphone users under fluorescent light)





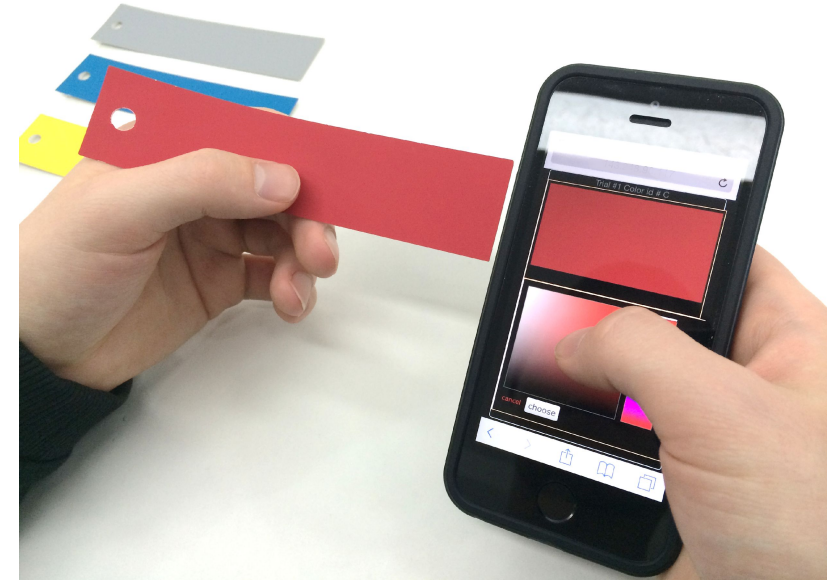
# Experiment 1: CrowdColor Generation

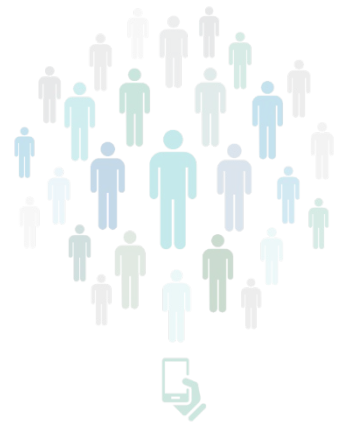
## Goal:

- Generate CrowdColor and assess its accuracy.
- Observe crowd worker's color perception and selection ability.

## Method:

- 31 participants (12 females), in lab controlled experiment
- 4 (colors) × 2 (lighting conditions) × 2 (devices)

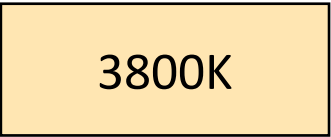




# Experiment 1: CrowdColor Generation

Color stimuli: Red, blue, yellow, gray

Lighting conditions: Daylight(5400K), Incandescent(3800K)



Display device: Samsung Galaxy S4 (AMOLED), iPhone 5s (IPS)



# Experiment 1: CrowdColor Generation

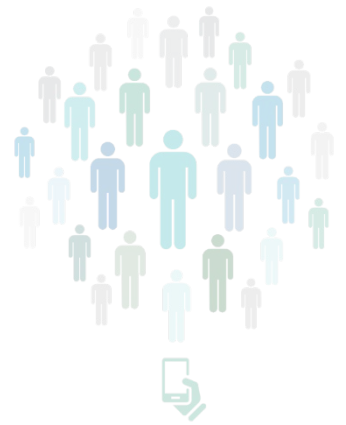
From the user inputs, we generated two types of CrowdColors:

- 1) Adaptively-mapped CrowdColor (**ACC**): hypothetically the **best case**
- 2) Reversely-mapped CrowdColor (**BCC**): hypothetically the **worst case**

All the CrowdColors were measured with spectrophotometer to acquire color accuracies

(accuracy = color difference between the color stimuli and the CrowdColor)





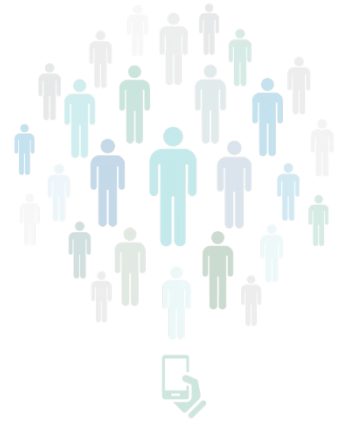
# Experiment 1: Results

The best performing case was B1 ( $\Delta E = 2.0 < JND \approx 2.3$ )

All ACC outperformed RCC.

Stimuli	Type	Galaxy S4	Color Distance ( $\Delta E$ )
		iPhone 5s	
S1	ACC	A1	3.7
		B1	2.0
	RCC	C1	6.7
		D1	5.1
S2	ACC	A2	8.0
		B2	17.5
	RCC	C2	10.1
		D2	19.5

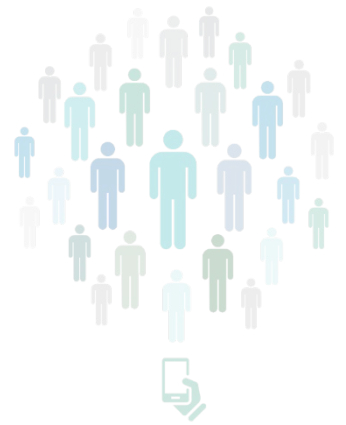
Stimuli	Type	Galaxy S4	Color Distance ( $\Delta E$ )
		iPhone 5s	
S3	ACC	A3	9.7
		B3	7.8
	RCC	C3	14.7
		D3	12.1
S4	ACC	A4	14.4
		B4	13.7
	RCC	C4	20.0
		D4	15.7



# Experiment 1: Results

Effect of color, light, and device on color accuracy:

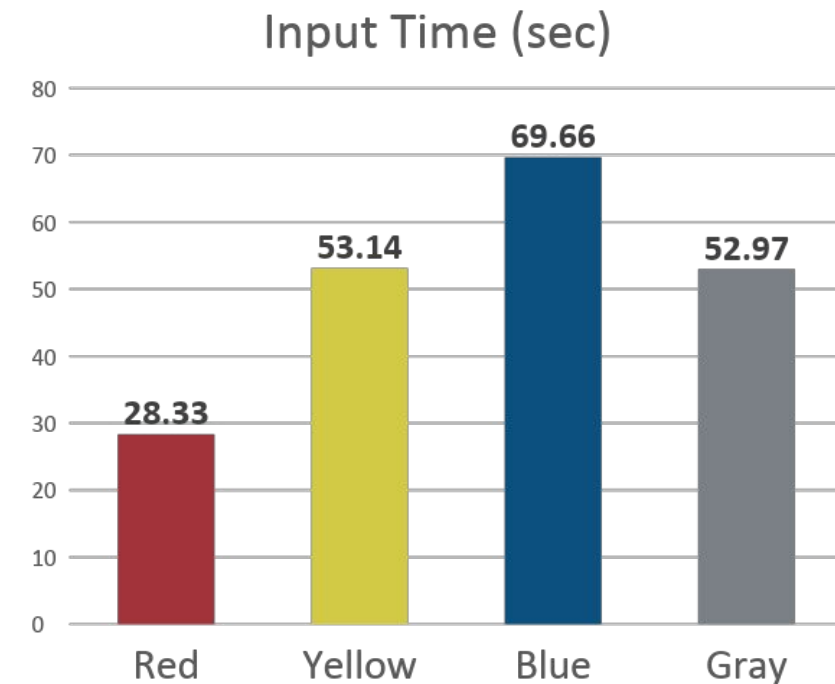
- 1) Both color and light had a significant effect on color accuracy
- 2) Device did not independently affect color accuracy
- 3) Interaction effect of the color and device on the color accuracy marginally significant.



# Experiment 1: Results

Effect of color, light, and device on input time:

- 1) Only the color had a significant effect on time.
- 2) Yellow, blue, gray required more effort than red
  - Consistent with the post interview, where more than 50% users reported yellow and blue were hard to locate.







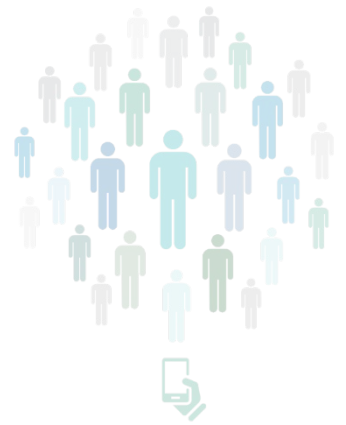
# Experiment 2: CrowdColor User Evaluation

## Goal:

- Assess the subjective agreement level of perceived color similarity

## Method:

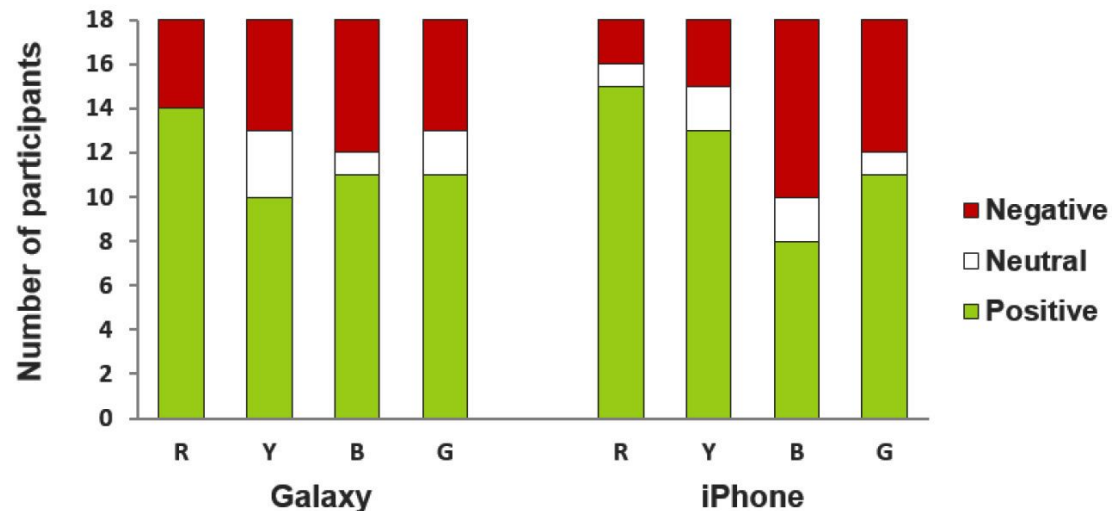
- 18 participants, given 2 devices, under 2 lighting conditions
- Evaluate perceived color accuracy of previously generated CrowdColors
- Only evaluated the best performing ACCs
- Total of 144 responses collected



# Experiment 2: Results

## CrowdColors were positively accepted overall

- 73% were positive or neutral
- Exit interview revealed CrowdColor was not precisely the same
- But it is more trustworthy than the images provided by the sellers





# Limitations

## **Not all colors are locatable**

: Display device cannot represent all colors that exists in the real world

## **Controlled settings**

: Current study was a in lab experiment. In the wild study could decrease its accuracy

## **Different types of materials needs to be tested**

: We mainly considered standardized color papers. Further study of various materials (e.g. fabric, metal) needs to be conducted for generalizability.



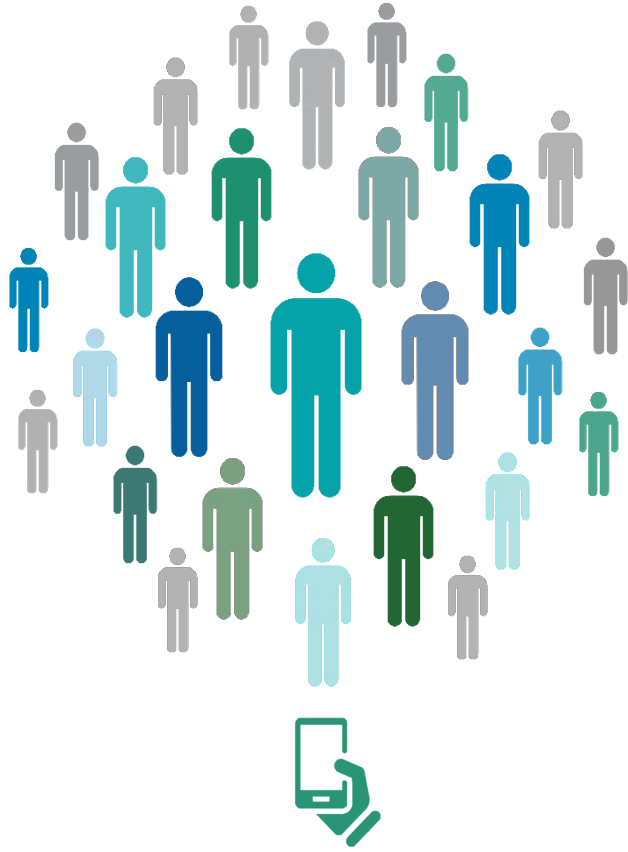
# Conclusion & Future Work

**Explored viability of crowdsourcing color inputs from a real world object.**

**The accuracy of the CrowdColor was examined in relation to environmental factors.**

**User study revealed it is positive overall and trustworthy in online shopping.**

**Large-scale, in-situ study will be conducted in the future.**



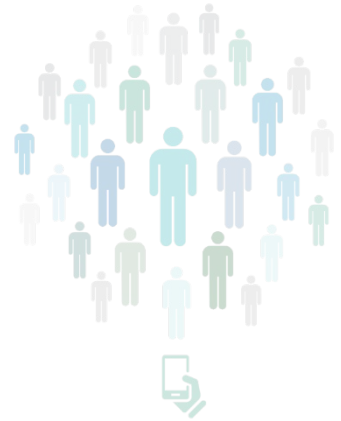
**Please visit [CrowdColor.net](https://CrowdColor.net)  
and try for yourself!**

Thank you

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**KAIST**

# Color Difference ( $\Delta E$ )



The “color gap” is the existence of color difference ( $\Delta E$ ) between the displayed image ( $L_1^*, a_1^*, b_1^*$ ) and the physical object ( $L_2^*, a_2^*, b_2^*$ ).

$$\Delta E_{ab}^* = \sqrt{(L_2^* - L_1^*)^2 + (a_2^* - a_1^*)^2 + (b_2^* - b_1^*)^2}$$

$L$  = lightness

$a^*, b^*$  = color-opponent dimensions

$\Delta E_{ab}^* \approx 2.3$  is JND(Just Noticeable Difference)

