ALNAIR INNOVATIONS


SIMON FRASER UNIVERSITY

SCHOOL OF ENGINEERING SCIENCE


ENSC 305/440 PROJECT PRESENTATION

# ColorAid


**TEAM MEMBERS**

- ARASH AHMADI
- HIN HENG CHAN
- CLARET RAMOS
- JUN KI HONG
- WILLIAM SEO


APRIL 12, 2011

# Individual Roles



- Claret Ramos - Chief Executive Officer
  - Project Manager
  - Color perception theory research and Component research
  - Central Processor Unit and Color Sensing Unit development and testing
  - Hardware design, implementation and testing
- Henry Hin Heng Chan - Chief Hardware Officer
  - Component Research
  - Central Processor Unit development and testing
  - User Interface Unit development and testing (LCD implementation)
- Arash Ahmadi - Chief Software Officer
  - Component Research
  - User Interface Unit development (LCD implementation)
  - Color testing

# Individual Roles



- Wooseouk William Seo - Chief Financial Officer
  - Central Processor Unit development and testing and Color testing.
  - Hardware implementation
  - Component Research
  - Allocation of funds

- Jun Ki Hong - Chief Communications Officer
  - Colorimetry and color perception theory research
  - Component Research
  - Color Sensing Unit development and testing
  - Documentation review and approval

# Presentation Outline



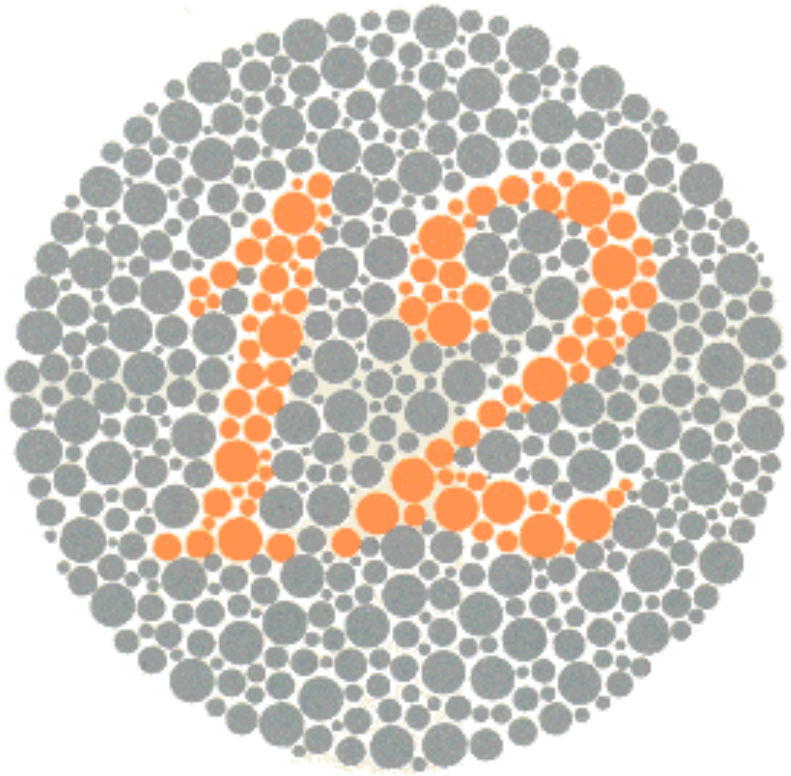
ALNAIR INNOVATIONS

- Motivation
- Project Description
- System Overview
- High Level System Design
- Functional Specifications
- Business Approach
- Budget and Timeline
- Future Work and Conclusion
- Acknowledgement
- References
- Questions
- Demo

# Motivation

# What number do you see?

6



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# What number do you see?

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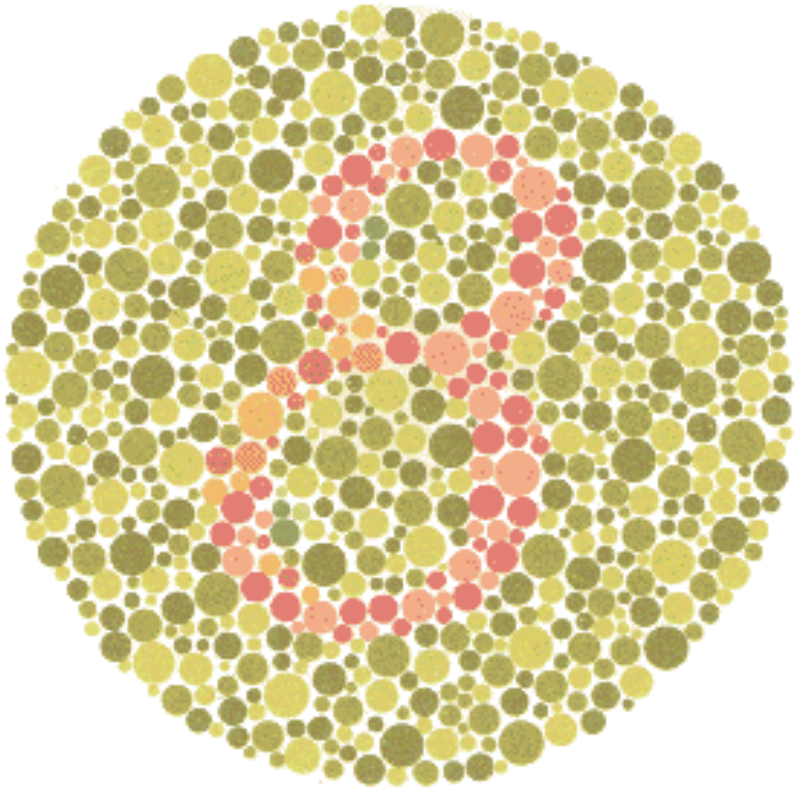

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# What number do you see?

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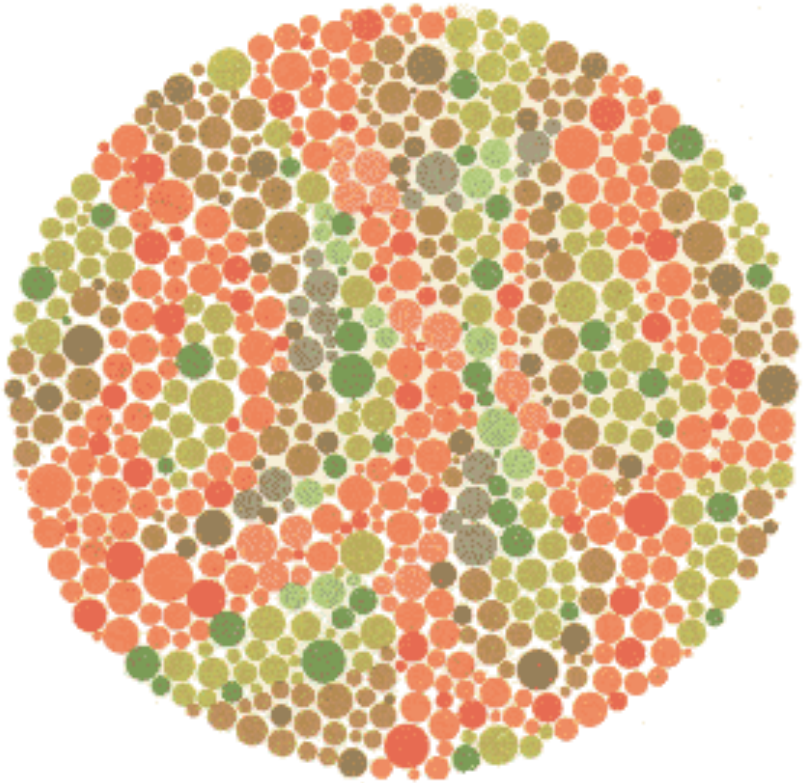

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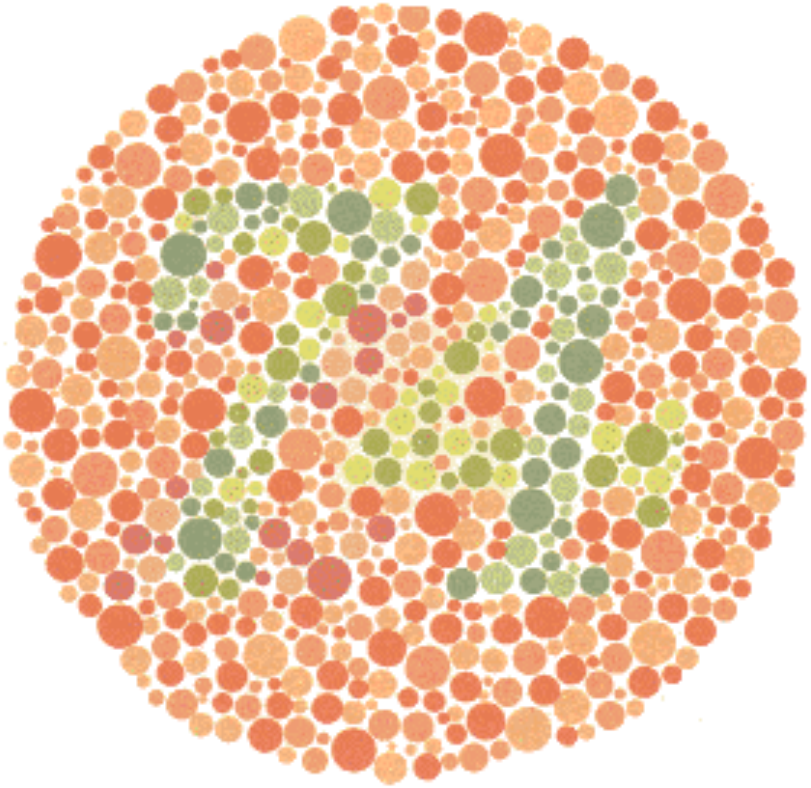

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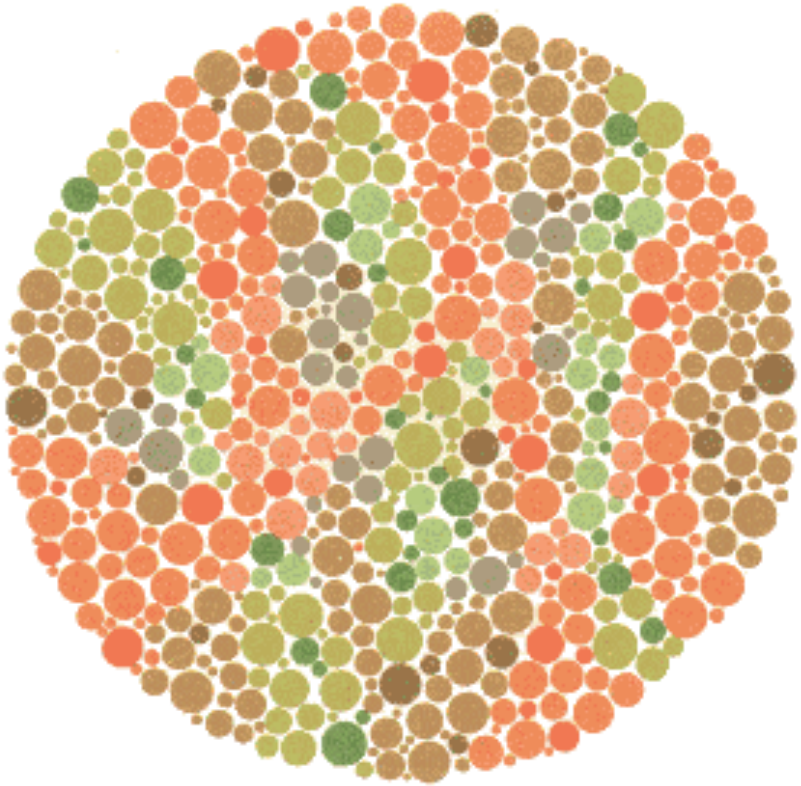
# What number do you see?





# YOU SHOULD SEE NUMBER:

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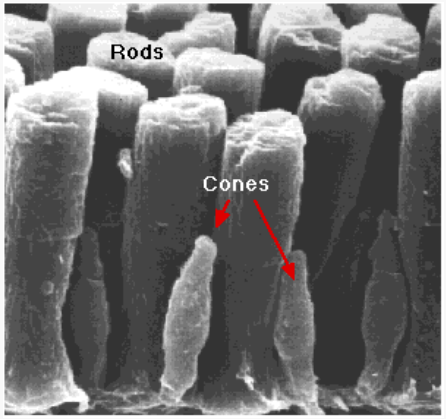
# Am I colorblind?

# About Color Vision



- Vision is one of the five senses humans rely on to interpret information from the environment
- The eye allows us vision through different cells called rods and cones which are located in the retina
- The rods are in charge of light perception, and they are responsible for night vision. The cones are in charge of color perception

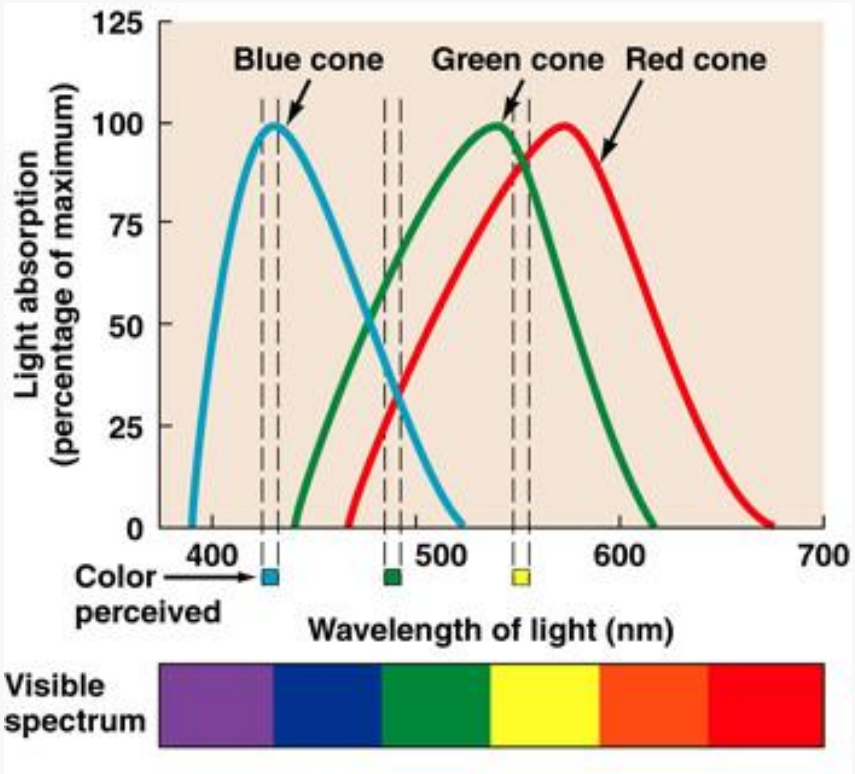


# About Color Vision



- Normally, there are three types of cones, each containing a different pigment, that reacts to one of three wavelengths of light: red, green and blue

- The brain combines the information from the three receptors to give rise to different perceptions of color



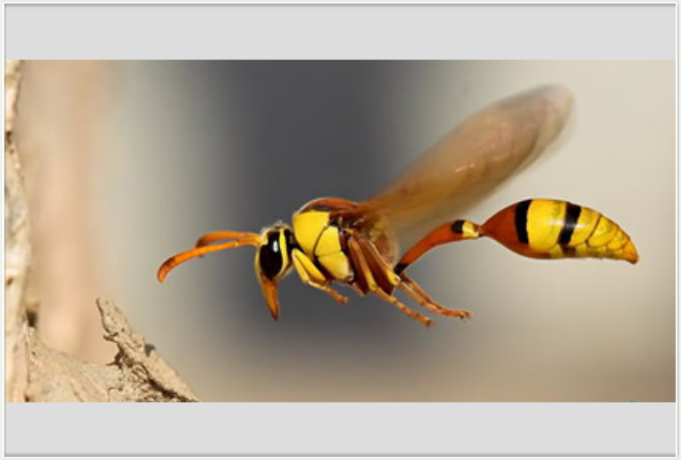
# About Color Vision

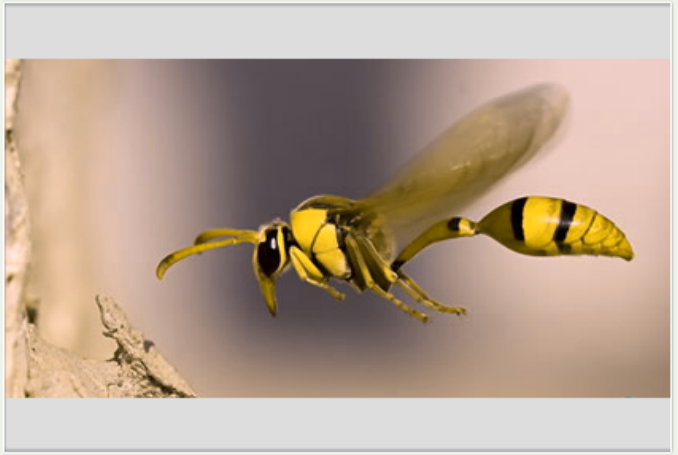


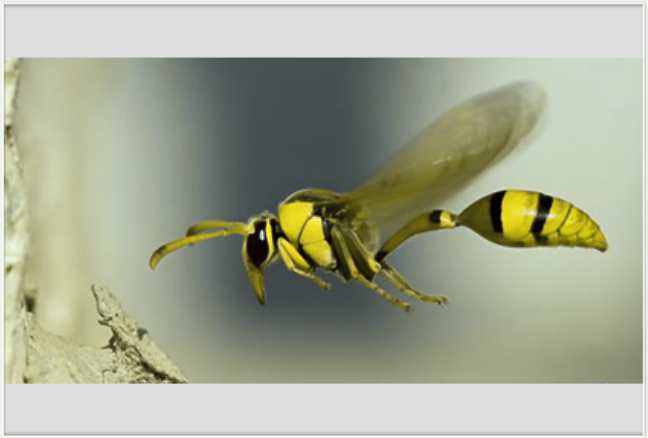
- When at least one of these three cone receptors is defective or absent, the individual experiences color blindness
- There are different types of color deficiency. Dichromacy, trichromacy and monochromacy
- Color deficiency is most commonly caused by a genetic mutation, but it can also occur because of aging or some eye, nerve, or brain damage

# Color Vision Deficiencies



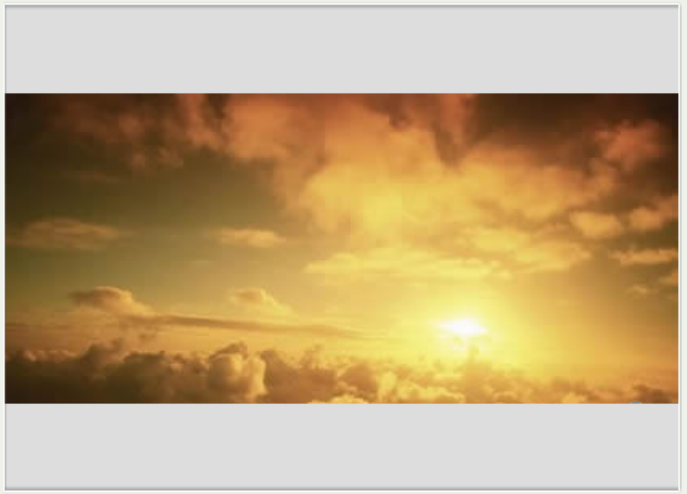


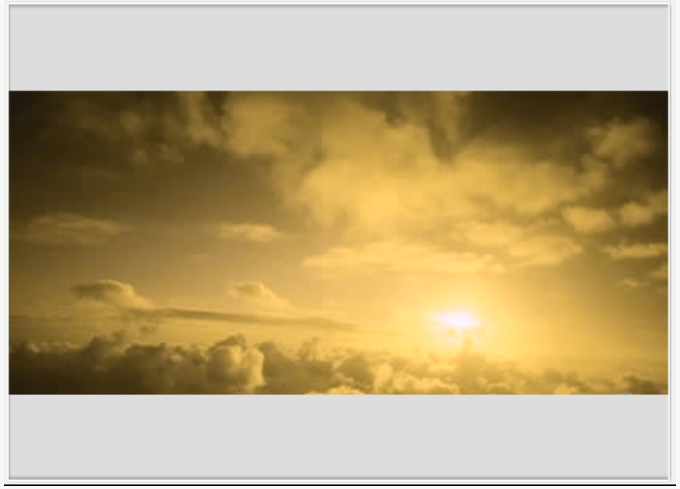


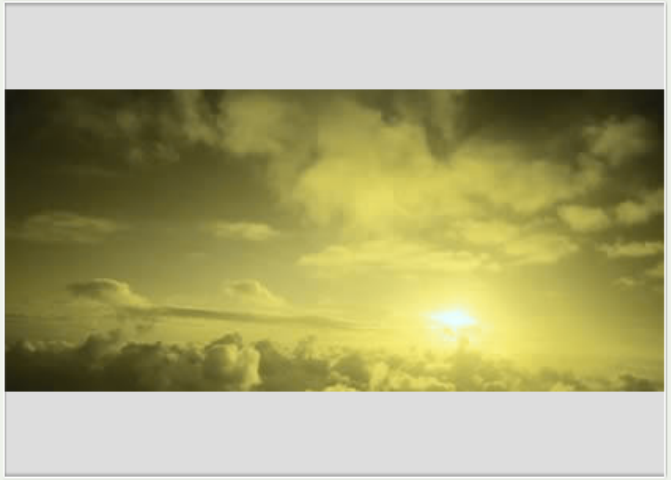


# Color Vision Deficiencies









# Childhood



# CHILDHOOD




# CHILDHOOD



# CHILDHOOD



# CHILDHOOD



# Challenges



- The world in which we live is not colorblind friendly.
- People with color deficiency encounter challenges on a day to day basis.

# Challenges



# CHALLENGES



# Challenges



# CHALLENGES




DELHI
GHAZIABAD
HARYANA
JAHANGIRPURI
ADARSH NAGAR
AZADPUR
MODEL TOWN
G.T.B. NAGAR
RITHALA
ROHINI WEST
ROHINI EAST
PITAMPURA
KOHAT ENCLAVE
NETAJI SUBHASH PLACE
KESHAV PURAM
KANHAIYA NAGAR
KHYBERPASS DEPOT
VIDHAN SABHA
CIVIL LINES
KASHMERE GATE
SHASTRI PARK DEPOT
WELCOME
MANSAROVAR PARK
DILSHAD GARDEN
JHILMIL
SHAHDARA
SEELAMPUR
SHASTRI PARK
VISHWA VIDYALAYA
TIS HAZARI
PRATAP NAGAR
SHASTRI NAGAR
MODERN SCHOOL
PEERAGARHI
SHIVA JI PARK
PUNJABI BAGH
PASCHIM VIHAR (East)
PASCHIM VIHAR (West)
MADI PUR
UDYOG NAGAR
NANGLOI RLY. STN.
SURA JMAL STADIUM
RAJDHANI PARK
NANGLOI
MUNDKA
RAMESH NAGAR
KIRTI NAGAR
MOTI NAGAR
SUBHASH NAGAR
RAJOURI GARDEN
TAGORE GARDEN
JANAK PURI EAST
JANAK PURI WEST
TILAK NAGAR
SHADIPUR
PATEL NAGAR
KAROL BAGH
RAJENDRA PLACE
SATGURU RAM SINGH MARG
JHANDEWALAN
CHANDNI CHOWK
CHAWRI BAZAR
NEW DELHI
RAJIV CHOWK
BARAKHAMBA ROAD
PATEL CHOWK
CENTRAL SECRETARIAT
MANDI HOUSE
PRAGATI MAIDAN
INDRAPRASTHA
YAMUNA BANK
YAMUNA DEPOT
NIRMAN VIHAR
LAXMI NAGAR
AKSHARDAM TEMPLE
MAYUR VIHAR - I
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KHAN MARKET
PRITHVI
TAJ PALACE
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NOIDA SECT. 18
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BOTANICAL GARDEN
SECT. CITY CEN
PREET VIHAR
KARKARDUMA
ANAND VIHAR ISBT
KAUSAMBI
VAISHALI
UTTAM NAGAR WEST
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DWARKA MOR
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NAJAFGARH DEPOT
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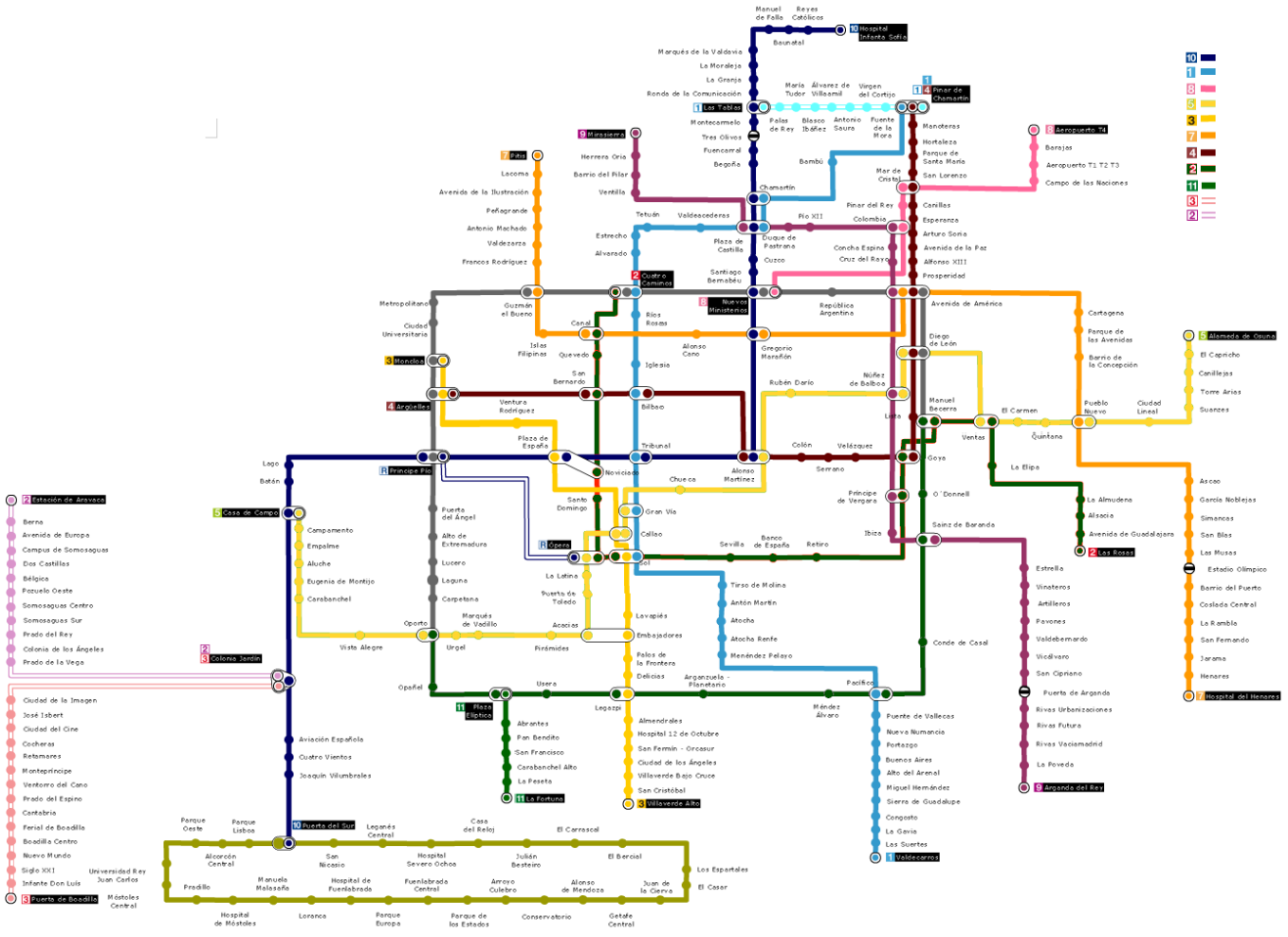
DWARKA SEC-8
DWARKA SEC-21
AIRPORT
NH8
JASOLA
SARITA VIHAR
SARITA VIHAR DEPOT
MOHAN ESTATE
TUGHLAKABAD
SULTANPUR
GHITORNI
Prashanth

# CHALLENGES

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Montecarmelo
Tres Olivos
Fuencarral
Begoña
María Tudor
Álvarez de Villaamil
Virgen del Cortijo
1 4 Pinar de Chamartín
Palas de Rey
Blasco Ibáñez
Antonio Saura
Fuente de la Mora
Manoteras
Hortaleza
Parque de Santo María
San Lorenzo
Mar de Cristal
9 Mirasierra
Herrera Oria
Barrio del Pilar
Ventilla
7 Pitis
Lacoma
Avenida de la Ilustración
Peñagrande
Antonio Machado
Valdezarza
Francos Rodríguez
Chamartín
Tetuán
Valdeacederas
Pío XII
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Colombia
Carrillas
Esperanza
Arturo Soria
Avenida de la Paz
Alfonso XIII
Prosperidad
Estrecho
Alvarado
Duque de Pastrana
Plaza de Castilla
Cuzco
Concha Espina
Cruz del Rayo
Santiago Bernabéu
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8 Nuevos Ministerios
Metropolitano
Guzmán el Bueno
Ciudad Universitaria
Canal
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República Argentina
Avenida de América
Islas Filipinas
Quevedo
Alonso Cano
Gregorio Marañón
Diego de León
3 Moncloa
San Bernardo
Iglesia
Rubén Darío
Núñez de Balboa
4 Argüelles
Ventura Rodríguez
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Manuel Becerra
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Lista
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Noviciado
Chueca
Alonso Martínez
Serrano
Goya
La Elipa
Santo Domingo
Gran Vía
Príncipe de Vergara
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Puerta de Toledo
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Valdebernardo
Vicálvaro
San Cipriano
Puerta de Arganda
Rivas Urbanizaciones
Rivas Futura
Rivas Vaciamadrid
La Poveda
9 Arganda del Rey
Conde de Casal
Lavapiés
Embajadores
Palos de la Frontera
Delicias
Arganzuela - Planetario
Pacífico
Méndez Álvaro
Puente de Vallecas
Nueva Numancia
Portazgo
Buenos Aires
Alto del Arenal
Miguel Hernández
Sierra de Guadalupe
Congosto
La Gavia
Las Suertes
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Acacias
Pirámides
Marqués de Vadillo
Oporto
Vista Alegre
Urgel
Lucero
Laguna
Carpetana
Eugenia de Montijo
Carabanchel
Alto de Extremadura
Puerta del Ángel
Campamento
Empalme
Aluche
Casa de Campo
Opañel
Usera
Legazpi
11 Plaza Elíptica
Abrantes
Pan Bendito
San Francisco
Carabanchel Alto
La Peseta
11 La Fortuna
Almendrales
Hospital 12 de Octubre
San Fermín - Orcasur
Ciudad de los Ángeles
Villaverde Bajo Cruce
San Cristóbal
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7 Estación de Aravaca
Berna
Avenida de Europa
Campus de Somosaguas
Dos Castillas
Bélgica
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Prado del Rey
Colonia de los Ángeles
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Cocheras
Retamares
Montepríncipe
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Nuevo Mundo
Siglo XXI
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Universidad Rey Juan Carlos
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Móstoles Central
Aviación Española
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Alcorcón Central
San Nicasio
Hospital Severo Ochoa
Julián Besteiro
El Bercial
Los Espartales
El Casar
Pradillo
Manuela Malasaña
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Fuenlabrada Central
Arroyo Culebro
Alonso de Mendoza
Juan de la Cierva
Hospital de Móstoles
Loranca
Parque Europa
Parque de los Estados
Conservatorio
Getafe Central
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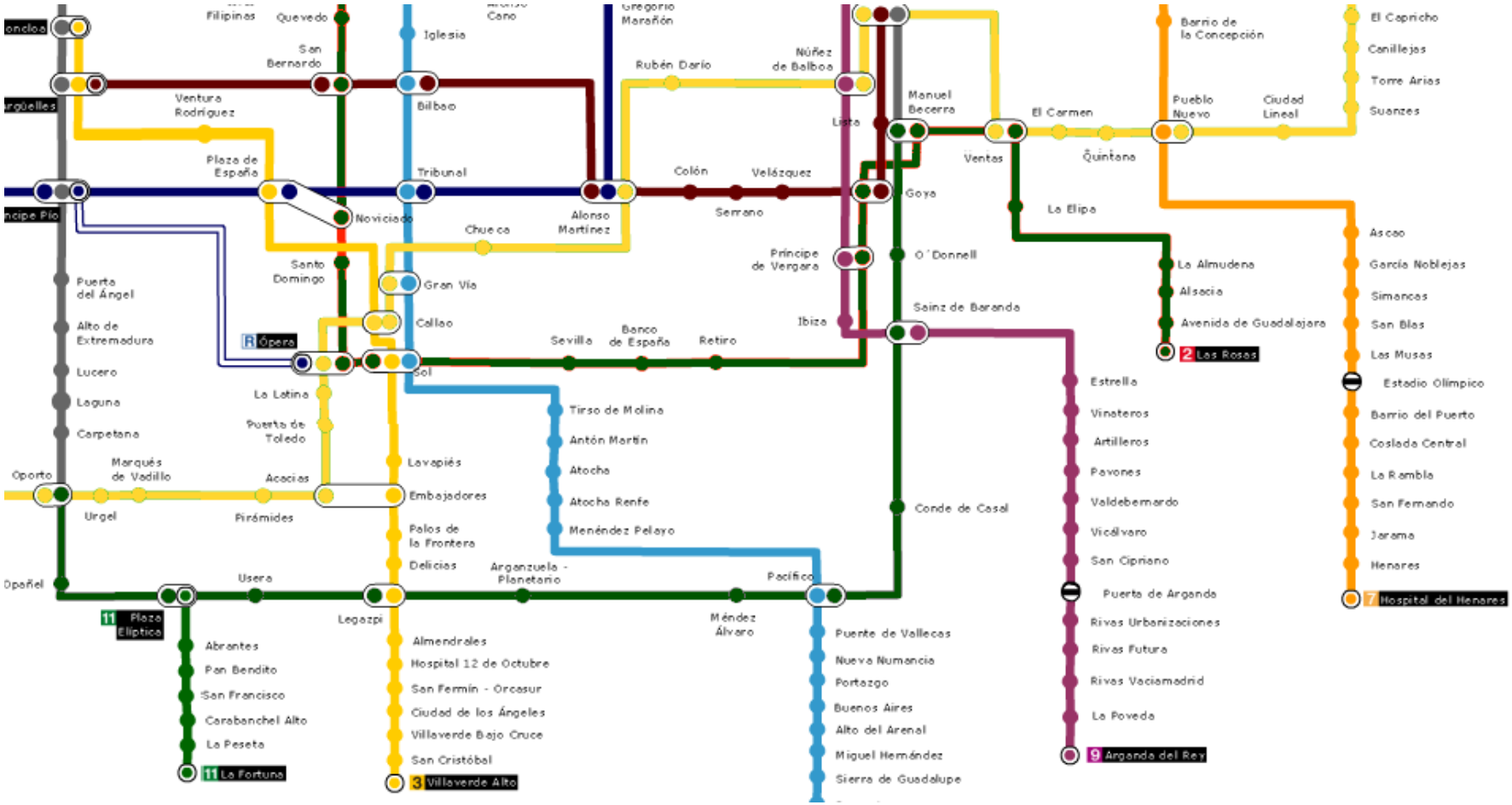
Ascao
García Noblejas
Simancas
San Blas
Las Musas
Estadio Olímpico
Barrio del Puerto
Coslada Central
La Rambla
San Fernando
Jarama
Henares
7 Hospital del Henares

# CHALLENGES

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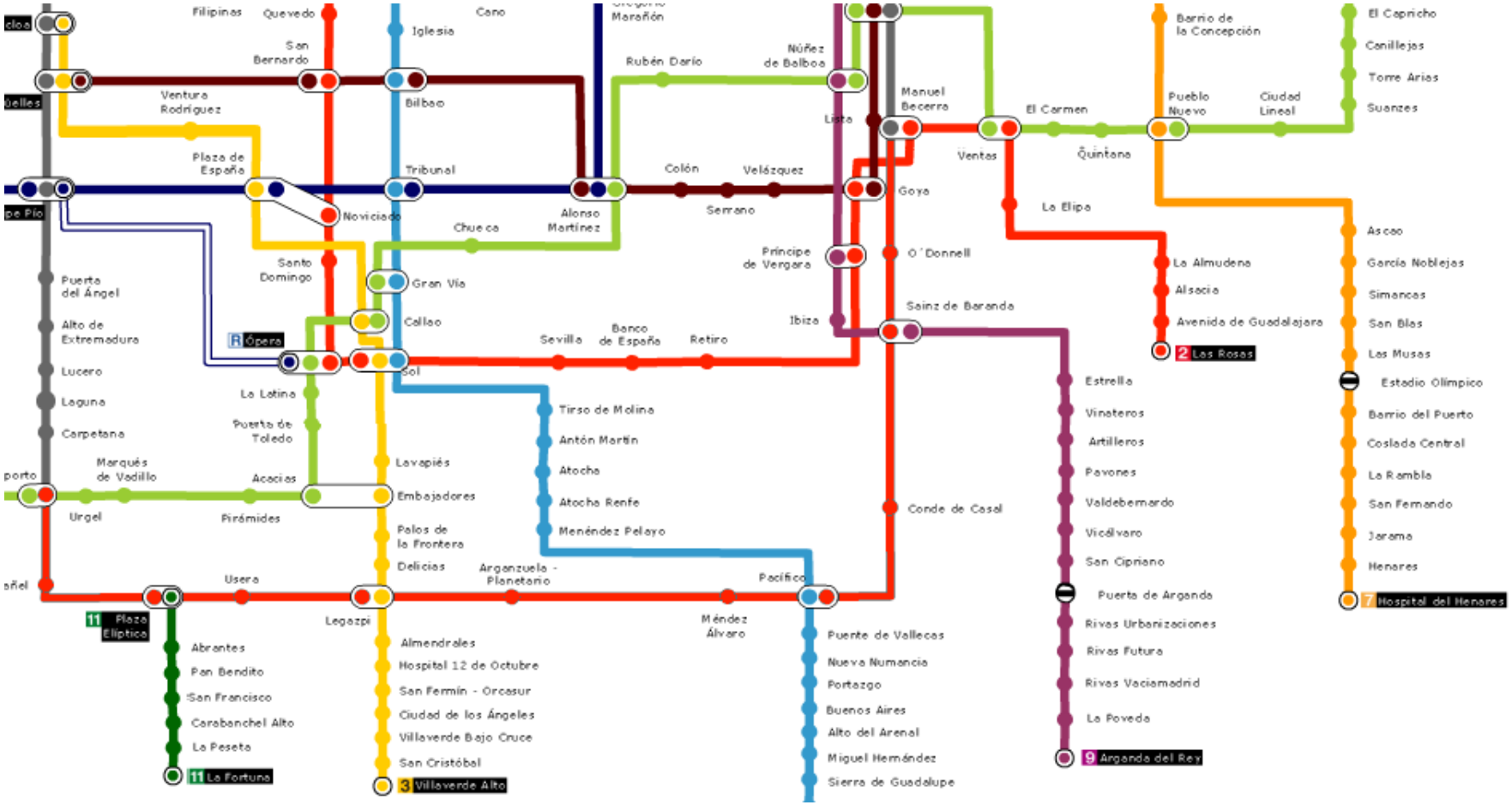
3 Villaverde Alto

# CHALLENGES

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La Latina
Puerta de Toledo
Marqués de Vadillo
Acacias
Pirámides
Urgel
Lavapiés
Embajadores
Palos de la Frontera
Delicias
Tirso de Molina
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Almendrales
Hospital 12 de Octubre
San Fermín - Orcasur
Ciudad de los Ángeles
Villaverde Bajo Cruce
San Cristóbal
3 Villaverde Alto

# CHALLENGES

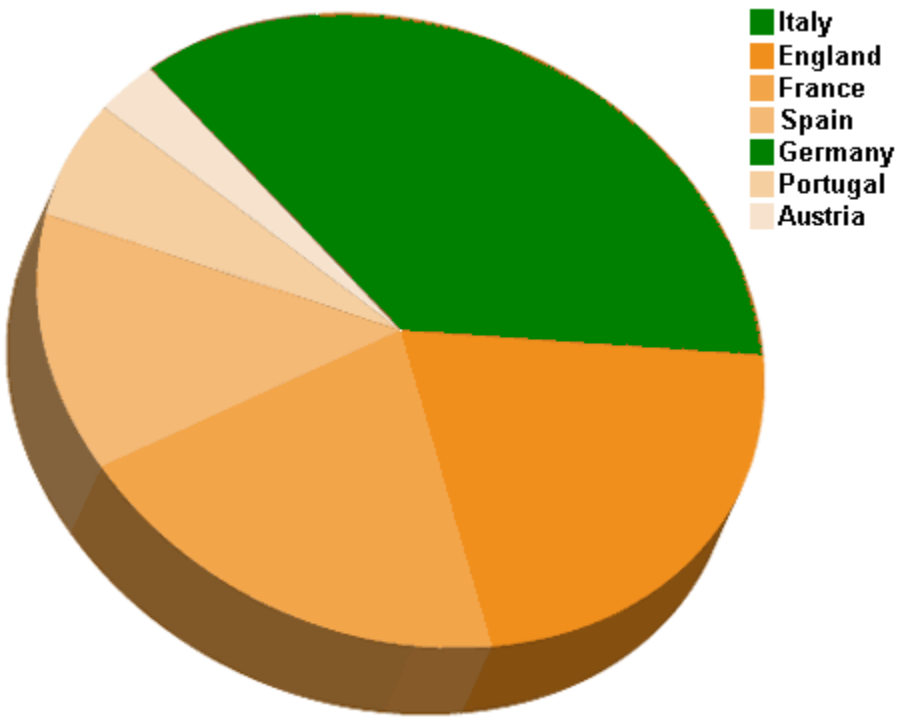


# CHALLENGES



# Challenges: Charts

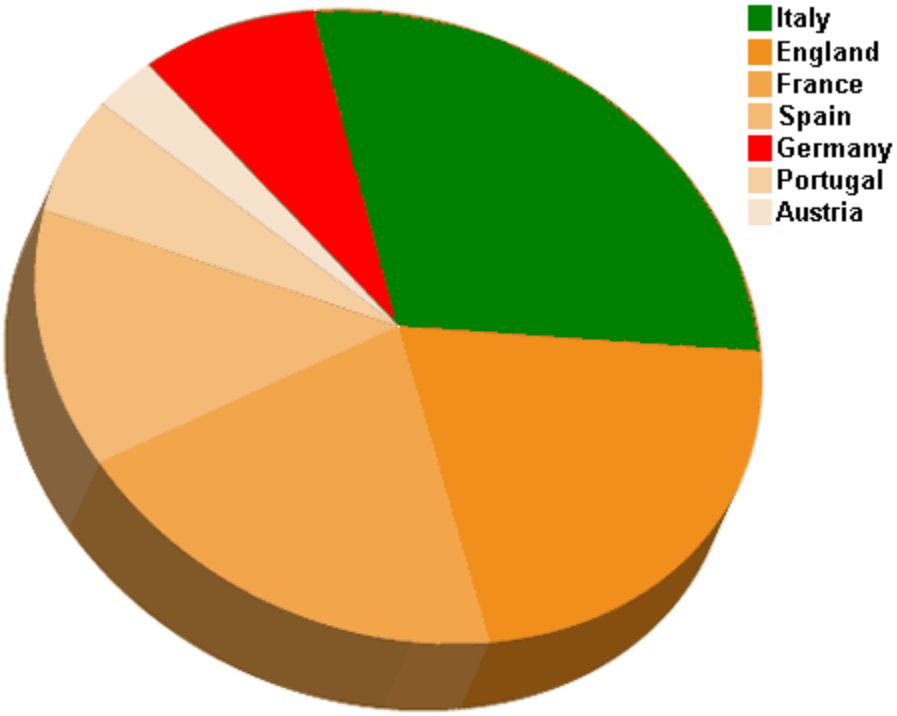





Percentage of People that watch Soccer in selected Countries

# Challenges: Charts






Percentage of People that watch Soccer in selected Countries

# Challenges



# CHALLENGES



# Challenging Fields



- Pharmacy/chemistry
- Medical doctor, lab technician
- Dentistry, dental technician
- Nursing
- Film
- Photography
- Arts/painting
- Interior design
- Graphic design
- Game design
- Fashion
- Web Site Developers and Designers (color scheme)
- Teacher (color related tasks)
- Architect
- Atmospheric scientists
- Geological engineers, geoscientist.
- Army, fighter pilot, infantry, special forces, artillery, jobs that not involve combat arms
- Truck, taxi drivers
- Jewels

# SOLUTION TO THIS PROBLEM



- Given this problem, Alnair Innovations has taken the steps needed to aid the individuals with color vision deficiency by developing a device called ***ColorAid***.

# ColorAid



- ***ColorAid*** is a portable device to aid with color recognition.
- It uses high sensitivity color sensor with filter-coated photodiodes to sample the reflected light from objects.
- The data is analyzed and converted into digital RGB readings.
- Through an LCD screen the user can view the name of the color sampled, the RGB, and color match.

# ColorAid



- ***ColorAid*** is an excellent tool that can help not only people suffering from a genetic color deficiency, but also individuals that have lost some color perception due to the aging process or damage.

- Given the versatility of ***ColorAid***, it can be taken anywhere, and it is designed to be used in daily activities not only by adults but by children, parents and teachers.

- ***ColorAid*** will help people to face life with more confidence, assisting them in their daily tasks, and not only giving them assurance of what they see, but also allowing them to live an independent life with accurate knowledge of the colors that surround them.

# With ColorAid

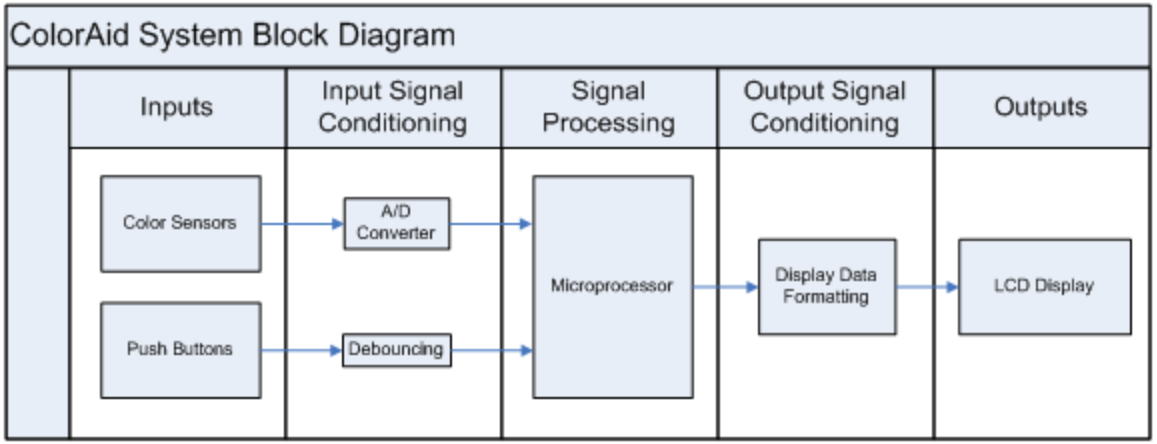


# System Block Diagram

Inputs: Color Sensor (ADJD-S311), User Push Buttons

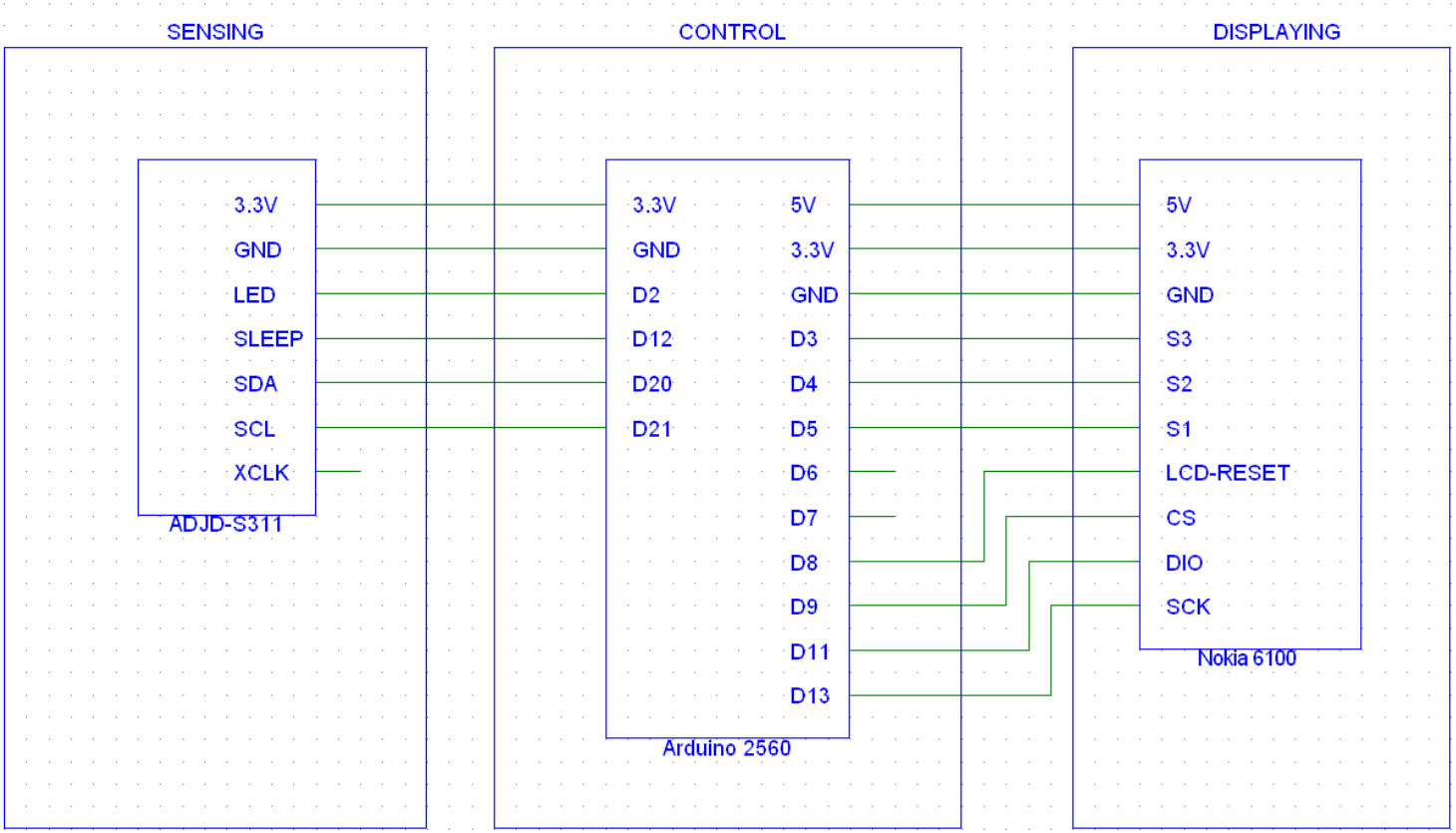
MCU: Arduino Mega 2560 (ATMega2560)

Output: LCD display (Nokia 6100)



# CONNECTION LAYOUT






- Pin Layout of Sensor to MCU, Display unit to MCU

# Top-Layer Program Overview



## Flow Chart


## Pseudo-Code

**1. Turn on ColourAid**

# Top-Layer Program Overview



## Flow Chart


## Pseudo-Code

1. Turn on ColourAid
2. **Initial setup**

# Top-Layer Program Overview



## Flow Chart


## Pseudo-Code

1. Turn on ColourAid
2. Initial setup
3. **Main Menu selection**

# Top-Layer Program Overview



## Flow Chart


## Pseudo-Code

1. Turn on ColourAid
2. Initial setup
3. Main Menu selection
4. **Repeat**
   - 4.1. Check Sub-Menu flag
   - 4.2 . Go to Sub-Menu subroutine
   - 4.3. return back to Main Menu

# Top-Layer Program Overview



## Flow Chart


## Pseudo-Code

1. Turn on ColourAid
2. Initial setup
3. Main Menu selection
4. Repeat
    - 4.1. Check Sub-Menu flag
    - 4.2 . Go to Sub-Menu subroutine
    - 4.3. return back to Main Menu
5. **Turn off ColourAid**

# Top-Layer Program Overview



## Flow Chart


## Pseudo-Code

1. Turn on ColourAid
2. Initial setup
3. Main Menu selection
4. Repeat
    - 4.1. Check Sub-Menu flag
    - 4.2 . Go to Sub-Menu subroutine
    - 4.3. return back to Main Menu
5. Turn off ColourAid
6. **STOP**

# Micro Controller Unit



| Functional Requirement | Arduino Mega 2560 |
| --- | --- |
| R64, R65, R66, R67: Enough In/out Ports to receive data from sensor and sends information to display unit | |

# Micro Controller Unit



| Functional Requirement | Arduino Mega 2560 |
| --- | --- |
| R64, R65, R66, R67: Enough In/out Ports to receive data from sensor and sends information to display unit | • MCU: ATMega2560<br>• 16MHz clock<br>• TWI communication<br>• 52 digital in/out ports |

# Micro Controller Unit



| Functional Requirement | Arduino Mega 2560 |
| --- | --- |
| R64, R65, R66, R67: Enough In/out Ports to receive data from sensor and sends information to display unit<br>R68: Configure Menu Selection<br>R69: Enough memory space to save color data and display color value | • MCU: ATMega2560<br>• 16MHz clock<br>• TWI communication<br>• 52 digital in/out ports |

# Micro Controller Unit



| Functional Requirement | Arduino Mega 2560 |
| --- | --- |
| R64, R65, R66, R67: Enough In/out Ports to receive data from sensor and sends information to display unit<br>R68: Configure Menu Selection<br>R69: Enough memory space to save color data and display color value | • MCU: ATMega2560<br>• 16MHz clock<br>• TWI communication<br>• 52 digital in/out ports<br>• SRAM 8KB, EEPROM 4KB<br>• Flash Memory 256KB |

# Micro Controller Unit



## Functional Requirement

R64, R65, R66, R67: Enough In/out Ports to receive data from sensor and sends information to display unit

R68: Configure Menu Selection

R69: Enough memory space to save color data and display color value

R70: must be powered up by 9V battery

## Arduino Mega 2560

- MCU: ATMega2560
- 16MHz clock
- TWI communication
- 52 digital in/out ports
- SRAM 8KB, EEPROM 4KB
- Flash Memory 256KB

# Micro Controller Unit



| Functional Requirement | Arduino Mega 2560 |
| --- | --- |
| R64, R65, R66, R67: Enough In/out Ports to receive data from sensor and sends information to display unit<br>R68: Configure Menu Selection<br>R69: Enough memory space to save color data and display color value<br>R70: must be powered up by 9V battery | • MCU: ATMega2560<br>• 16MHz clock<br>• TWI communication<br>• 52 digital in/out ports<br>• SRAM 8KB, EEPROM 4KB<br>• Flash Memory 256KB<br>• Powered up by 7~12V DC |

# WHY ARDUINO?

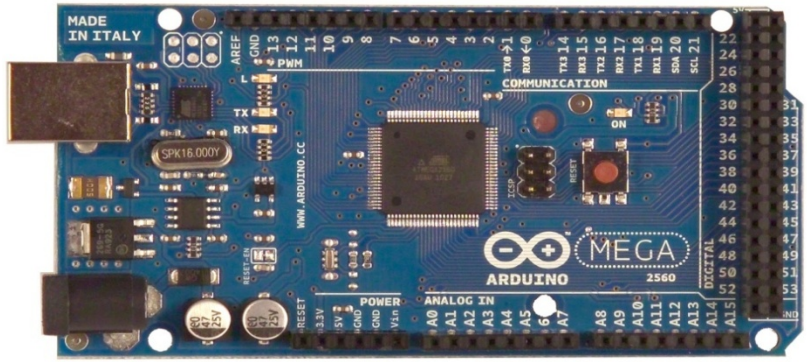


## Microcontroller Manufacture

- Freescale
- Intel
- Atmel
- PIC
- Texas Instruments
- Toshiba

## Strong Features

- Provide open source software, No need to pay license fee
- C/C++ compatible
- Cheap Price



# Arduino Software Code Sample



```
void    setup()
{
        Serial.begin(9600);
        // Initialize Sensor Unit
        Wire.begin();
        pinMode(ModeSensorLED, OUTPUT);
        powerOnReset();
        delay(10);
        initGainReg();
        // Initialize LCD
        ioinit();           //Initialize ARM I/O
        LCDInit();          //Initialize the LCD
//--c   LCDContrast(44);
        LCDClear(BLACK);
        LCDPrintLogo();

        // Determine if color is masked to be display or
        for ( int i = 0; i < 12; i += 4 )
        {
          // see if the color is masked. If it is, displa
          if ( EEPROM.read(i) == 1 )
          {
            color_mask_location[j] = i; //keep track of w
            album_data++; // increment the counter by 1 t

            ColorTable(EEPROM.read(i+1), EEPROM.read(i+2), EEPROM.read(i+3));
            color_name[j] = colorName;

            j++;
          }
        }

        delay(2000);        //delay 2 second
        LCDClear(BLACK);
        DrawMainPage(top_menu_count); // display initial menu
}
```

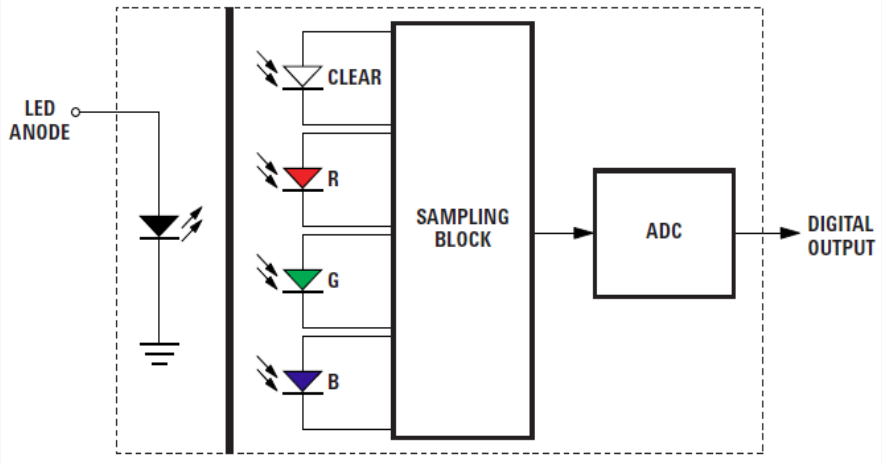
# Color Sensing Unit



- The color sensing unit is responsible for the actual color detection. The main component of this portion of the device is Avago's ADJD-S311-CR999 RGB digital color sensor module.

- This device operates via reflective color sensing, which means that the color sensor will detect the light reflected from the surface of the object sampled in order to recognize the color.

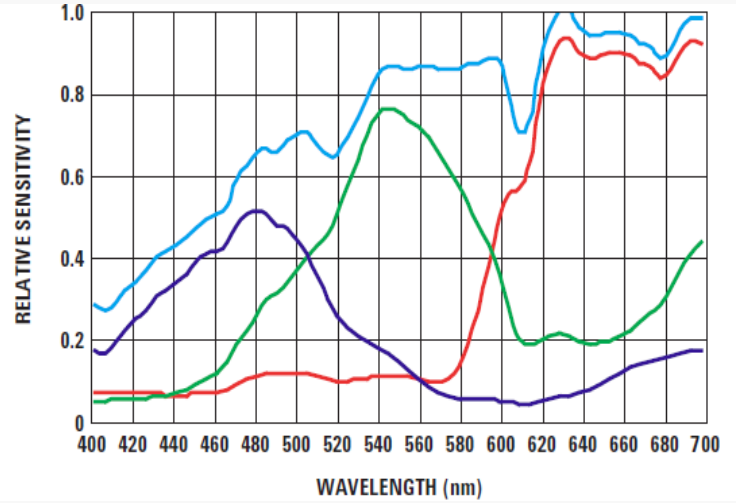
- Each channel has 10 bit resolution



# Color Sensing Unit



| Parameter | Symbol | Conditions | RGBC | Minimum Sensitivity | Maximum Sensitivity | Unit |
|---|---|---|---|---|---|---|
| Irradiance Responsivity | Re | $\lambda_p$= 460 nm | R | 152 | 3796 | LSB/(mW cm$^{-2}$) |
| | | $\lambda_p$= 542 nm | G | 178 | 4725 | |
| | | $\lambda_p$= 645 nm | B | 254 | 6288 | |
| | | $\lambda_p$= 645 nm | C | 264 | 6590 | |




Spectral response when the gains for all the color channels are set equal

# Color Sensing Unit



- ADJD-S311-CR999 color sensor module operates with 2-wire serial communication, which allows the chip to interface with the central processing unit.
- In order to set the gain of each channel, the module provides two independent gain parameters that can be adjusted: number of capacitor and integration time.
  - The higher the number of capacitor, the lower the sensitivity.
  - Low integration times corresponds to low time to sense, as longer time will result more photons to be sensed

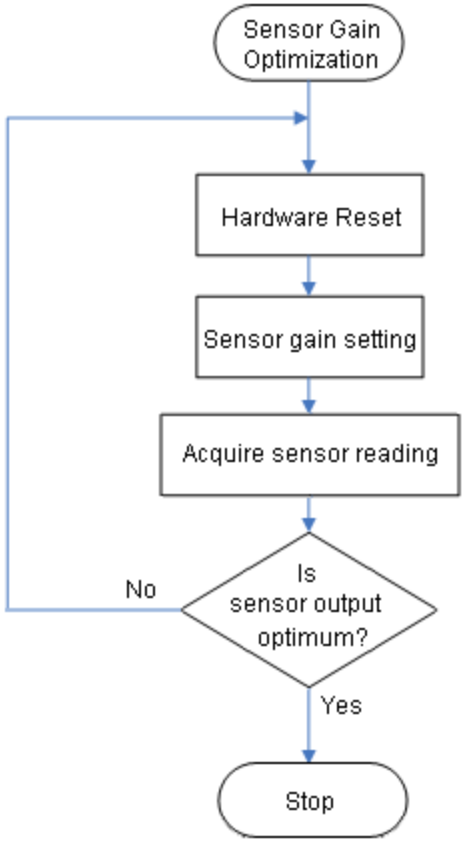
# CALIBRATION



- In the development of the project, we experimented with three types of calibration sources:
  - White LED (6500K color temperature)
  - Halogen light source (6500K color temperature)
  - White paper

- We obtained better results using white paper calibration as indicated in the datasheet of the Color Sensor.
  - One time calibration for the values of capacitors with white paper
  - Calibration for integration time is performed every time a color is sampled

# Sensor Gain Optimization Procedure



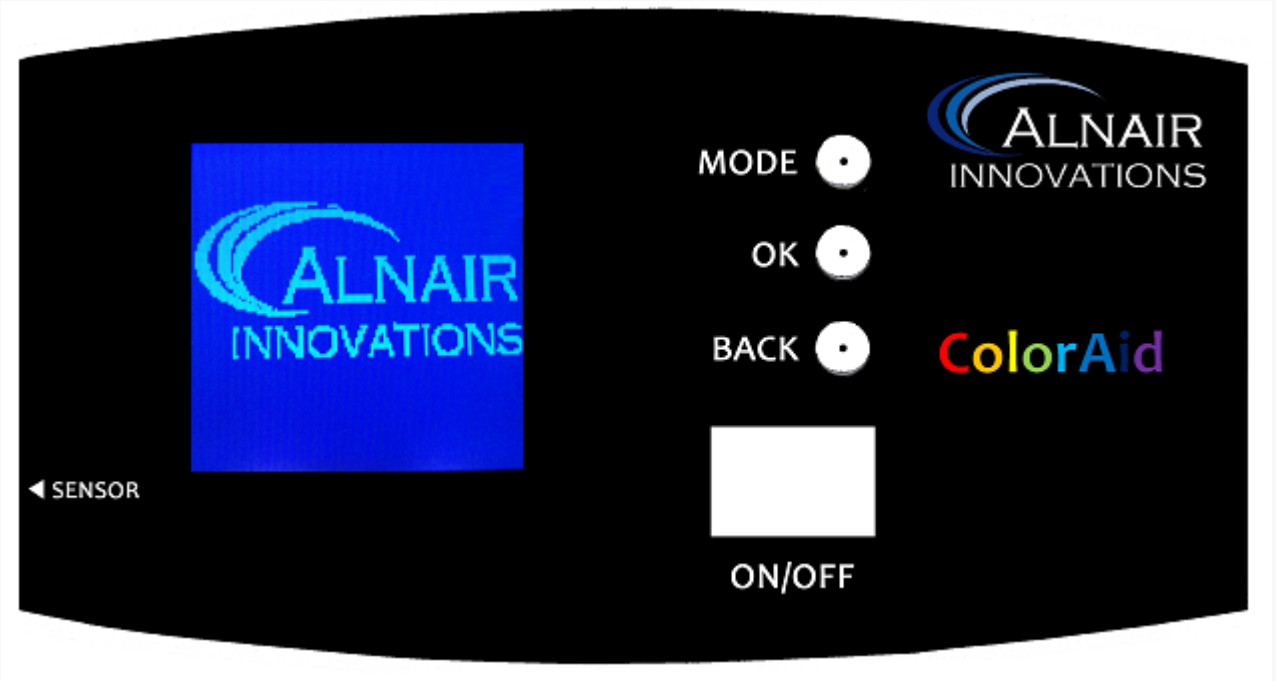
# User Interface Unit



- The user interface unit consists of a color LCD, three push-buttons and a power switch.
- The power switch is used to turn the unit on or off.
- The color LCD displays the menu
  - Sampling the color of an object
  - Storing the color obtained
  - Accessing saved colors
  - Color matching feature
  - Battery meter
- The three push-buttons are the following: “OK” button, “MODE” button, and “BACK” button.

# User Interface Unit





# Functional Specifications



- Physical Requirements
  - Dimensions: 15 cm x 9 cm x 3.5 cm
  - Weight: 300g
- Electrical Requirements
  - Battery: 9V
- Usability Requirements
  - Area to be sampled: 1 cm x 1 cm
- Reliability Test
  - 7 hours

# Business Aspects



- Who needs ***ColorAid***?
- Competition?
- Comparison

# WHO NEEDS *COLORAID?*



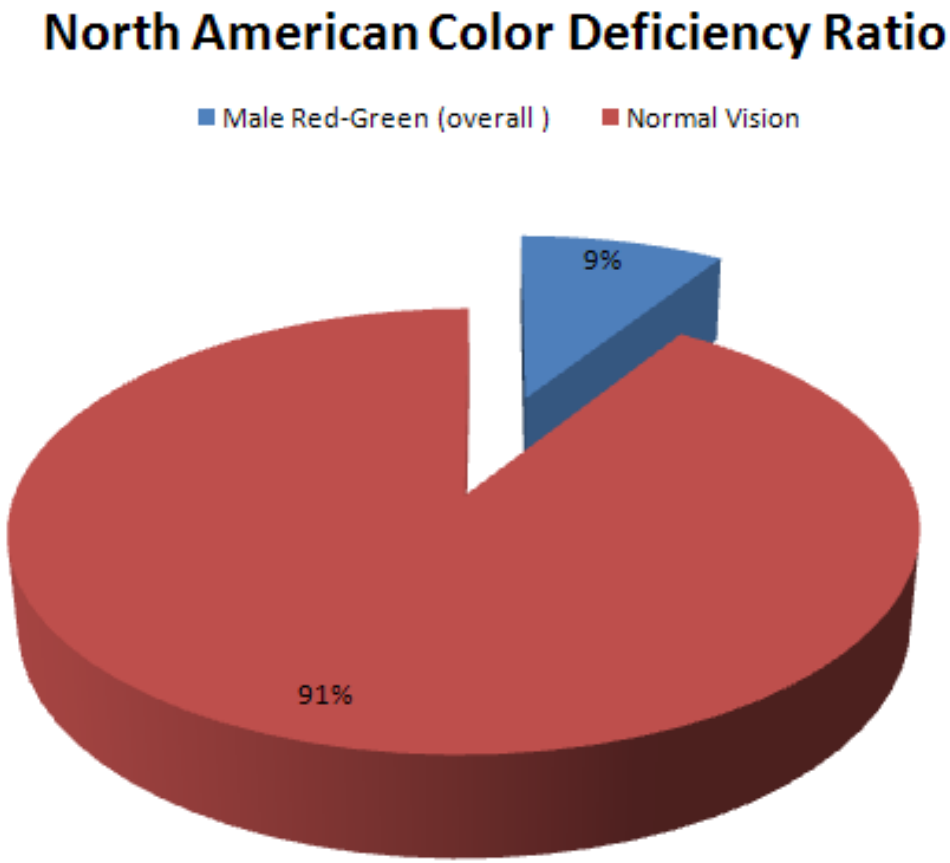
- Color Deficiency

- Those who have increasing difficulty of recognizing color from aging

- Those who need precise values for color

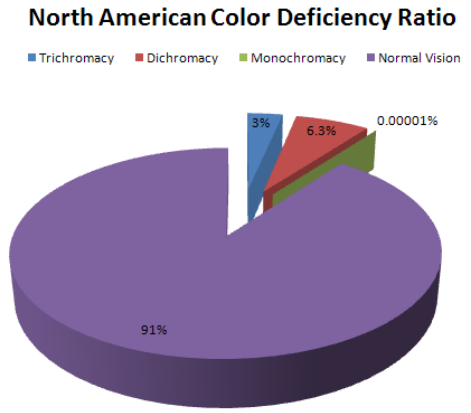
# North America Color Deficiency Ratio

72

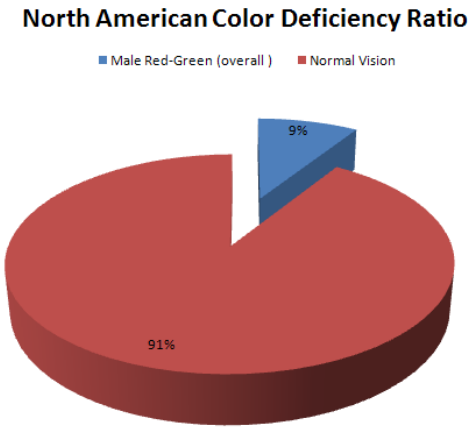


# Color Deficiency in North America: Population





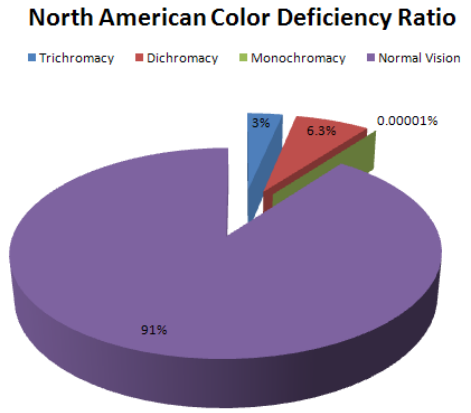

| Type of Color Deficiency | Population | Percentage (%) |
|---|---|---|
| Red-Green (overall) | | 9 |
| Normal Vision | | 91 |



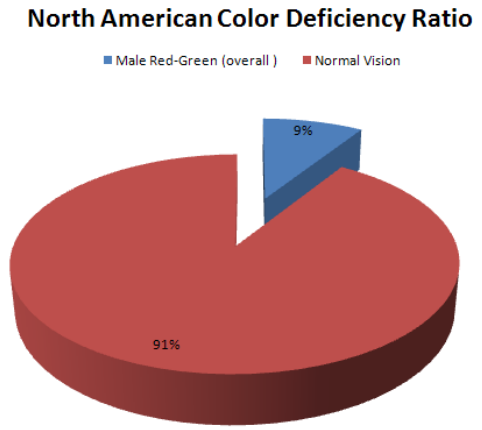

* The numbers in the table above are approximations to actual numbers, as of 2008.

# Color Deficiency in North America: Population






| Type of Color Deficiency | Population | Percentage (%) |
|---|---|---|
| Red-Green (overall) | 42,297,647 | 9 |
| Normal Vision | 528,720,588 | 91 |

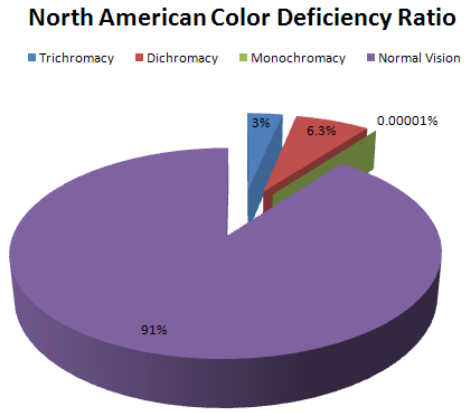


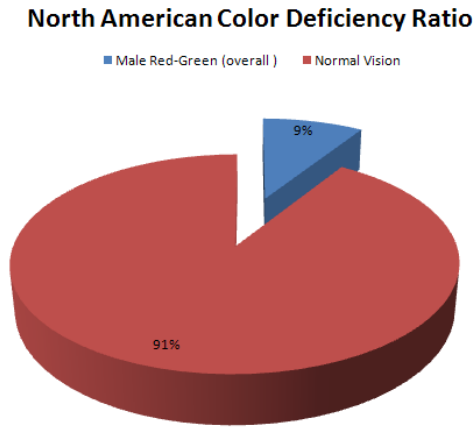

## Color deficients in the Rest of the world?

* The numbers in the table above are approximations to actual numbers, as of 2008.

# Color Deficiency in North America: Population






| Type of Color Deficiency | Population |
|---|---|
| Red-Green (overall) | 42,297,647 |
| Trichromacy | 15.861,617 |
| Dichromacy | 33,309,397 |
| Monochromacy | 529 |
| Normal Vision | 528,720,588 |

* The numbers in the table above are approximations to actual numbers, as of 2008.

# COMPETITION



- iPhone: Applications
- Features include:
  - Detect color
  - Clear view of the surface detected
  - Possibility of more applications

# COMPETITION



- iPhone: Applications

  Chromatic Glass


# COMPETITION

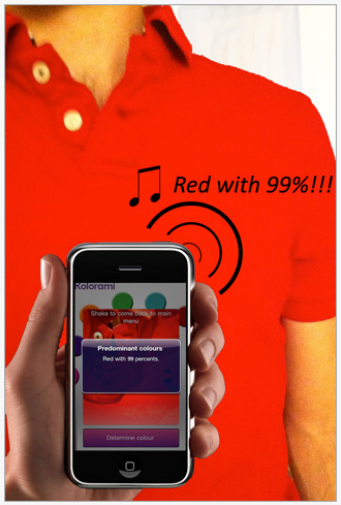


- iPhone: Applications

Chromatic Glass



Kolorami



# COMPETITION

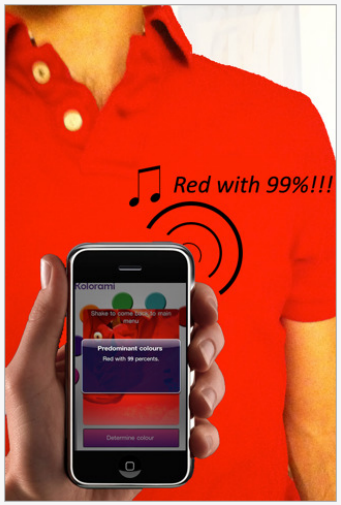


- iPhone: Applications

Chromatic Glass



Kolorami




How much is an iPhone?

# Competition

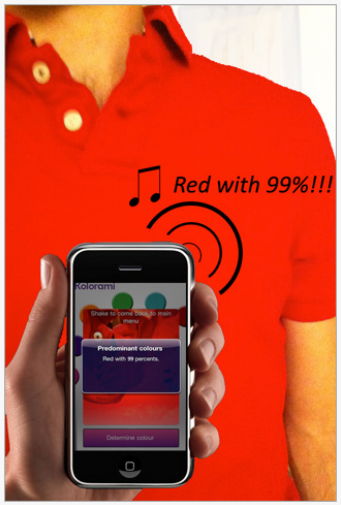


- iPhone: Applications

Chromatic Glass



Kolorami




How much is an iPhone?

*How many in the world can afford it?*

# COMPETITION



- Colorimeters and spectrometers

Product: **ColorTest Standard**

# COMPETITION



- Colorimeters and spectrometers

Product: **ColorTest Standard**
Features include:

- •Senses over 1,000 nuances of color.
- •Speaks in a clear, human voice.
- •Three operation buttons.
- •Built-in speaker.

**Price: ???**

# Competition



- Colorimeters and spectrometers

Product: **ColorTest Standard**
Features include:

- •Senses over 1,000 nuances of color.
- •Speaks in a clear, human voice.
- •Three operation buttons.
- •Built-in speaker.

**Price:** $670 !!!

# ColorAid



# ColorAid



- Features include:
  - Color Sensor detects 30 bit RGB value
  - Color LCD display of the name of the color
  - Save upto three colors detected
  - User friendly interface
  - 9V Battery/USB powered
  - In development,
    - Language options: English, Spanish, Chinese, Korean, Japanese and etc.
    - Increased number of colors that can be saved
    - Color matching (Demo implemented)

# ColorAid



- Features include:
  - Color Sensor detects 30 bit RGB value
  - Color LCD display of the name of the color
  - Save upto three colors detected
  - User friendly interface
  - 9V Battery/USB powered
  - In development,
    - Language options: English, Spanish, Mandarin, Cantonese, Korean, Japanese and etc.
    - Increased number of colors that can be saved
    - Color matching


Price??

# Device Cost



| Stage | Cost (per device) |
|---|---|
| Projected Cost | $400 |
| Actual Prototype Cost | |

| Large scale Production | Cost |
|---|---|
| 25 units | |
| 100 units | |
| 1,000 units | |

* The above approximate price analysis is based on Digikey and other similar products' price reduction with increasing quantity

*For the prototype, additional cost of approximately 40 dollars for battery, decos, wiring, and other materials is included

# Device Cost



| Stage | Cost (per device) |
|---|---|
| Projected Cost | $400 |
| Actual Prototype Cost | $150 |

| Large scale Production | Cost |
|---|---|
| 25 units | |
| 100 units | |
| 1,000 units | |

* The above approximate price analysis is based on Digikey and other similar products' price reduction with increasing quantity

*For the prototype, additional cost of approximately 40 dollars for battery, decos, wiring, and other materials is included

# Device Cost



| Stage | Cost (per device) |
|---|---|
| Projected Cost | $400 |
| Actual Prototype Cost | $150 |

| Large scale Production | Cost |
|---|---|
| 25 units | $66 |
| 100 units | |
| 1,000 units | |

* The above approximate price analysis is based on Digikey and other similar products' price reduction with increasing quantity

*For the prototype, additional cost of approximately 40 dollars for battery, decos, wiring, and other materials is included

# Device Cost



| Stage | Cost (per device) |
|---|---|
| Projected Cost | $400 |
| Actual Prototype Cost | $150 |

| Large scale Production | Cost |
|---|---|
| 25 units | $66 |
| 100 units | $54.5 |
| 1,000 units | $45.5 |

* The above approximate price analysis is based on Digikey and other similar products' price reduction with increasing quantity

*For the prototype, additional cost of approximately 40 dollars for battery, decos, wiring, and other materials is included

# COST BREAKDOWN



| | prototype | Mass production | | | |
|---|---|---|---|---|---|
| **Quantity** | **1** | **25** | **100** | **1000** | **10000** |
| **sensor** | 20 | 7.5 | 7.5 | 7.5 | **7.5** |
| **lcd** | 40 | 30 | 20 | 13 | 13 |
| **Microprocessor** | 72 | 11 | 11 | 11 | 11 |
| **switches** | 6.5 | 4.5 | 3 | 1 | 1 |
| **case** | 13 | 13 | 13 | 13 | 13 |
| **Total** | **151.5** | **66** | **54.5** | **45.5** | **45.5** |

* The price of the Microprocessor decreased drastically because the prototype required a development kit.

# Comparison



- Cost
  - iPhone vs. ColorTest Standard vs. ***ColorAid***
    - $500 vs. $??? vs. ~$??
- Market
  - North America and the Rest of the World

# Comparison



- Cost
  - iPhone vs. ColorTest Standard vs. ***ColorAid***
    - $500 vs. $670 vs. ~$??
- Market
  - North America and the Rest of the World

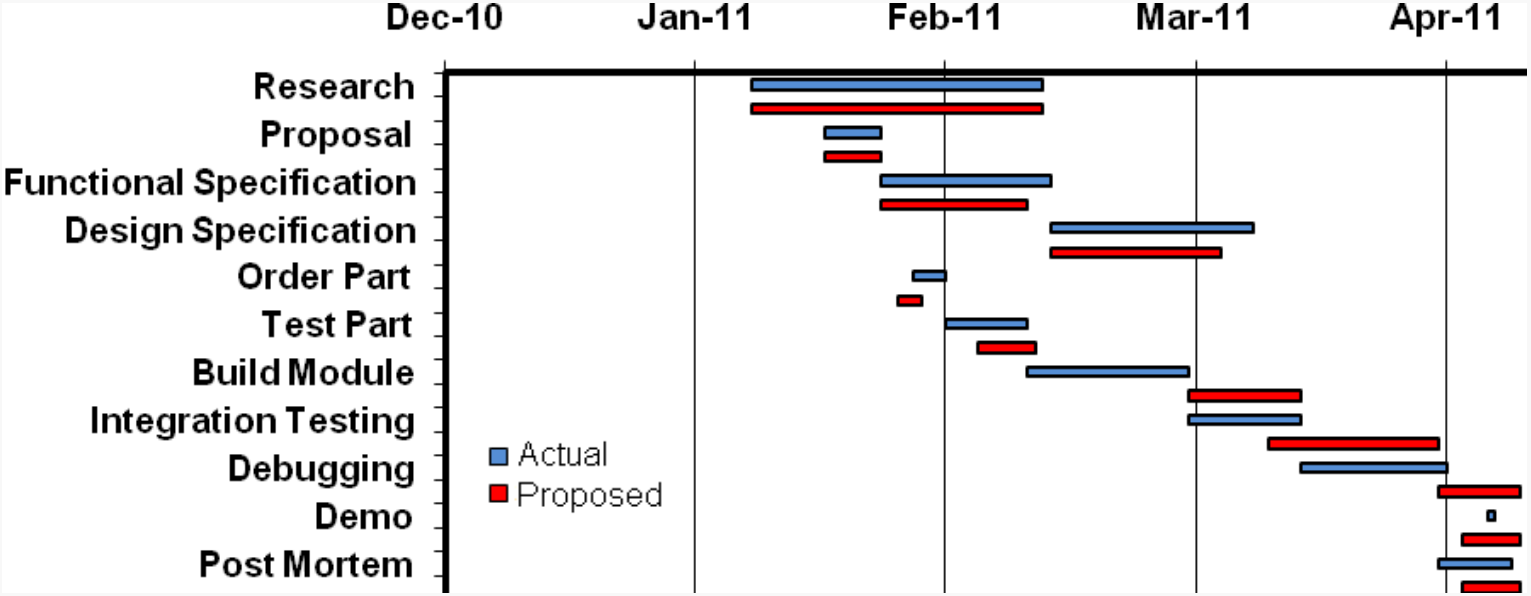
# Comparison



- Cost
  - iPhone vs. ColorTest Standard vs. ***ColorAid***
    - $500 vs. $670 vs. ~$50
- Market
  - North America and the Rest of the World
  - Direct approach to medical professionals

# TIMELINE






Projected timeline and actual timeline for designing and development

# FUTURE WORK



- Fully implement Color Wizard feature
- Acquire LCD screen with better color accuracy and resolution
- Increase the number of colors that can be stored
- Creation more completed database for color name
- Build our own PCB Layer and mount ATMega2560 chip to reduce size and also reduce power consumption
- Add better quality push buttons
- Make device smaller and lighter
- Include language option: English, Chinese, Korean, Japanese and other.

# CONCLUSION



- Portable ***ColorAid*** Device
  - Colour Sensor
  - Arduino Micro-Controller
  - LCD unit
- Interpersonal Skills
- Team work
- Problem Solving Skills
- No Boundaries for Knowledge

# ACKNOWLEDGEMENT



Thanks to:

- Dr. Andrew Rawicz
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- Ali Ostadfar
- Shaghayegh Hosseinpur
- Fred Heep
- Engineering Student Society
- Dr. Rafael Rodriguez
- Friends and Family

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# QUESTIONS



# Demonstration

# DEMO COLORAID



**START UP & DEMO WIZARD**

# Demo ColorAid



**DEMO ALBUM I**

**DEMO ALBUM II**

# Demo ColorAid



**DEMO SAVE 1**

**DEMO SAVE 2**

# DEMONSTRATION



- **Analog:** Analog colors are those that lie on either side of any given color. Analog colors are harmonious and give a natural feel.
- **Complement:** Complementary colors those located opposites in the color wheel. They are contrasting and usually used to highlight.
- **Triad:** Triad colors are three hues equidistant in the color wheel, which provide a balanced and colorful combination of colors.