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Multimedia Recoloring Technique for Protanopic CVD

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Abstract:-*Color Blindness Is A Result Of Absence Or Fault In One Of The 3 Cones In The Human Eye Or It Is Hereditary, Because Of This Deficiency The Color-Blind Users Also Called As Color Vision Deficient(CVD) Face Many Problem In Day To Day Life Like They Cannot Understand Traffic Signal, Road Maps Consisting Of Various Colors, Electrical Wires Etc. Since Now Everything Is Almost Digital And The Information Is Exchanged Through The Digital Media A Lot, The CVD Are Less Fortunate To Understand This Information. The RGB To LMS Algorithm Is Used To Recolor Those Pixels In Images And Videos Which Are Unperceivable To The Users. After Recoloring They Will Be Able To Distinguish The Colors And It Will Be More Understandable. We Have Focused On The Protanopia (Dichromacy) I.E. Red Green Color Deficiency. It Is Fast And It Maintains Color Consistency Among Frames.*

Keywords-*CB (Color Blind), CBP (Color Blindperceivable), CBU (Color Blind Unperceivable), Color Vision Deficiency (CVD),Long Medium Short(LMS).*

I. Introduction

Color Blindness Is A Deficiency Of Unrecognizing Certain Colors. The Person Cannot Distinguish Between Certain Colors Such As Red, Green And Sometimes Blue. A Human Can Perceive Colors Because Of Cones And Rods Present In The Eye. The Cones Are Responsible For Identifying Colors In High Light Levels And The Rods Are Responsible For Vision In Low Light Levels[1].

There Are 3 Types Of Cones In The Eye: Short Wavelength (Red Color), Medium Wavelength (Green Color) And Long Wavelength(Blue). The Brain Accepts The Input Through These Cones For Color Perception[2]. The Color Blindness Is Caused Due To The Absence Or Defect In One Of The Cones Or It Can Be Hereditary. There Is Different Form Of Color-Blindness, Some People Can Perceive Colors Normally In Bright Lights While They Have Problem In Dim Light And In Other Cases They Are Unable To Perceive In Any Light[3].

Figure 1 *Traffic Signal Perceived By Normal User Andcolour Blind User*

There Are 3 Forms Of Colour Blindness Viz.

Monochromacy –This Is Complete Colourblindness, Here The Person Can See All The Objects In Grey Scale I.E. Black And White Shades. This Is Due To Malfunctioning Or Absent Of Cones.

Dichromacy- This Involves Person Havingany 2 Cones In Eyes And There Is Absence Of One Cone Completely. There Are 3 Types Of Dichromacy

Protanopia- In This Case, The Cone That Issensitive To Red Colour Is Absent Completely. Hence, This Is Also Called As "Red Weakness". This Type Of Colour Blindness Affects 1% Of Men And 0.02% Of Women.
Deuteranopia –This Is Also Called As"Green Weakness", Here The Cone Sensitive To Green Light Are Absent. It Affects 1% Of Men And 0.01% Of Women.

Tritanopia-This Is Also Called As "Blueyellow Deficiency", Here The Cone That Is Sensitive To Blue Light Is Absent. It Affects About 0.002% Of Men And 0.001% Of Women.

Anomalous Trichromacy- Here Any 1 Coneis Not Completely Absent But They Malfunction. The Eyes Use 3 Cones In Different Proportions From The Normal Person. Hence, They Have Difficulty In Discriminating And Detecting Similar Shades. This Is Also Of 3 Types

Protanomaly- Malfunctioning In Red Cones.
Deuteranomaly –Malfunctioning In Greencones.

Tritanomaly- Malfunctioning In Bluecomes.

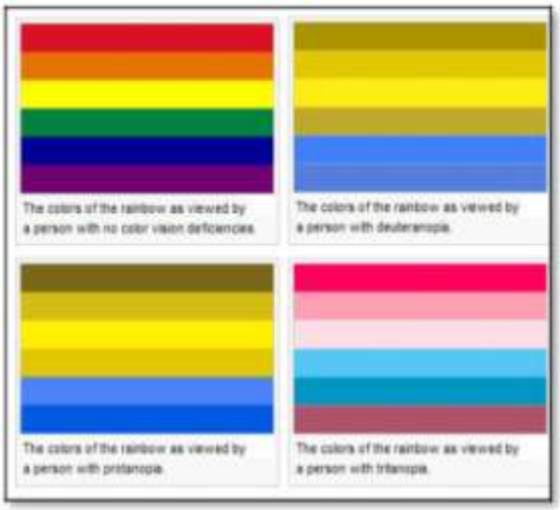


***Figure 2** The Colour Band Seen By Different Type Of Cvds*

The Exact Physical Causes Of Color Blindness Are Still Being Researched But It Is Believed That Color Blindness Is Usually Caused By Faulty Cones But Sometimes By A Fault In The Pathway From The Cone To The Brain. People With Normal Color Vision Have All Three Types Of Cone/Pathway Working Correctly But Color Blindness Occurs When One Or More Of The Cone Types Are Faulty. For Example, If The Red Cone Is Faulty You Won't Be Able To See Colors Containing Red Clearly. Most People With Color Blindness Can't Distinguish Certain Shades Of Red And Green. Color Blindness Is A Usually A Genetic (Hereditary) Condition (You Are Born With It). Red/Green And Blue Color Blindness Is Usually Passed Down From Your Parents. The Gene Which Is Responsible For The Condition Is Carried On The X Chromosome And This Is The Reason Why Many More Men Are Affected Than Women.

Thus Color Blindness Is A Kind Of Defect In Cones Which Causes A Person To Not Perceive One Primary Color Completely Or Confuse Between Two Primary Colors That Is Red, Green, And Blue Or Yellow. Now Lots Of Important Activities Like Watching Traffic Signals, Understanding Signs Of Various Roads, But These Activities Are Beyond Control As Recoloring Of These Important Activities Is Not Possible. In Similar Way, Color-Blinds Cannot Experience Multi-Media. As It Is Important For Any Person To Percieve Multimedia, He/She Should Distinguish All 3 Primary Colors I.E. Red, Green And Blue Easily. Color Blinds Also Suffer While Experiencing Multimedia, As They Are Not Able To Percieve All 3 Primary Colors Due To Defect Of Cone Cells Present In Retina. Red Color Vision Deficiency Is Most Wide-Spread Amongst Color-Blindness, Thus This Paper Contains The Explanation Of One Algorithm Which Is Proposed For Recoloring The Image And Video Is Such A Way That Even A Protanopic Person Which Able To Distinguish All 3 Primary Colors Easily. As Protanopic Person Can Never See Red Color, It Is Not Possible To Show Him/Her Red Color In Any Means. Hence The Algorithm Tries To Re-Color The Red Color In Such A Way That It Maps

Red Color With Another Color In Such A Way That All 3 Primary Colors Are Seen Distinguishably By The Color Vision Deficient.

II. Proposed System

Requirements Of The Proposed Algorithm Are:

1) The Difference Between The CBU Andcbp Colors Increases By Improving The Color Perceptibility Of The Image.

2) The TCC Has To Be Maintained.

3) To Enhance The Local Contrast In The Regionof The CBU Color.

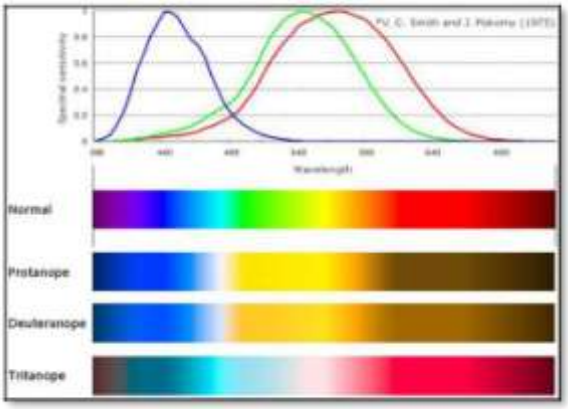


Figure 3 *Comparative View Of RGB Wavelength Of Normal And CVD User*

The Working Of The Proposed Method Is As Follows:

A. CBU Color Detection

CBU Color Detection Is The Process Of Selecting The Colors To Be Modified[5]. The Most Involuntary Approach For CBU Color Detection Is To Select The Colors Which Havelarge Difference Between The Original Color And Its CBS Color. However, It Is Difficult To Maintain The TCC Because The Color To Be Converted Varies At Each Frame[6]. We Proposed A New CBU Color Detector. To Prevent The Color To Be Reversed, We Change The Reddish Color Extraction Function □ (X^0) As

□ (X^0) =1, If $R^0>G^0$

0, Otherwise

The Proposed Method Yield The Clearer Boundary In The CBU Color Region.

B. Color Mapping Strategy Selection

At Each Frame, We Select On Of Two Strategies For Color Mapping According To The Temporal Color Difference (*DT*). Let *DT* Be The Pixel-Value Distance Between The Pixel To Be Converted For Color Mapping And The Pixel In The Previous Frame At The Same Image Coordinate, C^0 . Then,

$DT= \Omega(Xt^0, Xt\text{-}1^0)$

Where Xt^0 And $Xt\text{-}1^0$ Are Respectively, The Color Vectors At The Same Image Coordinate, C^o, In The Current And Previous Frames.Based On *DT* , A Color Mapping Strategy (*CMS*) Is Selected As Follows:

CMS=CMSS, If $DT>T2$

Cmst, Otherwise

If $DT>T2$ For Large Motion, Color Rotation Is Performed By Using The Spatial Color Mapping Strategy (*Cmss*). Or, If $DT\leq T2$ For Small Motion, The Temporal Color Mapping Strategy (*Cmst*) Performs Fast Color Mapping By Using The Mapping Result Of The Previous Frame.

C. The Spatial Color Mapping Strategy

In The *Cmss* Region, Each CBU Color, X^0 , Is Updated To X^0 By Color Rotation With Angle $\Delta\Theta$.In The Proposed Method $\Delta\Theta$ Is Defined As A Sum Of Two Angles As

$\Delta\Theta= \Theta^g+ \Theta^l$

Where Θ^g And Θ^l Are, Respectively, The Global Rotational Angle And The Local Rotational Angle. Here, We Utilize CS To Assign Different Θ^l And Add It To The Angle For Rotating The CBU Color. Thus, The

Contrast Can Be Enhanced Not Only At The Border Of CBU Region But Also Inside The CBU Region. As A Result, We Obtain Θ^l At The Pixel Position C^o As

$\Theta^l =$ $GCSP(Bt,C^0)$

Where Is A Scale Factor To Satisfy $0 \leq \Delta\Theta = \Theta^g + \Theta^l \leq /2$

And $GCSP(BT,C^0)$ Is The CS Profile Generator Which Produces The CS Profile At C^o , By Using The Blue Channel, *Bt* , Of The Current Frame, *Ft*. Since The Blue Channel Is More Perceptible Than The Other Channels To The CB, We Utilize The Blue Channel As An Input Image Of The CS Profile Generator.

D. Temporal Color Mapping Strategy

In This Section We Introduces How To Utilize The Spatiotemporal Constraint To Reduce The Computational Cost While Preserving The TCC. For This Purpose, *Cmst* Finds The Pixel That Has The Mostsimilar Color In The Previous Frame And Performs The Color Prediction Process With A Simplified Operation. First, The Similar Color Searching (SCS) Finds $X^*T\text{-}1$ That Is The Most Similar Color In The Previous Frame, *Ft-1* Around The Same Position, C^o , Of The Input Color Xt^0 As

$Xt\text{-}1^{0=}$Arg Min (X , Xt^0),

$Xers(Ct\text{-}1^0)$

Where $Rs\ (Ct\text{-}1^0)$Is The Search Range Of The C^0in *Ft-1* . In The Proposed Method, We Set A Radius Of *Rs* To 2. Second, The Linear Color Prediction (LCP) Is Used To Find Xt^0 Using The RGB Components Of Xt^0, $Xt\text{-}1^0$, $X^*T\text{-}1$

As Follows:

$$Xt^0 = \begin{bmatrix} Rt^0 \\ Gt^0 \\ Bt^0 \end{bmatrix} = \begin{bmatrix} LP(R^0t, R^0t\text{-}1, R^*T\text{-}1) \\ LP(G^0t, G^0t\text{-}1, G^*T\text{-}1) \\ LP(B^0t, B^0t\text{-}1, B^*T\text{-}1) \end{bmatrix}$$

Where $LP(\cdot)$ Is A Linear Prediction Function Defined As

$LP(R^0t, R^0t\text{-}1, R^*T\text{-}1) = (R^0t - R^0t\text{-}1 / R^*T\text{-}1 - R^0t\text{-}1)\ R^0t\text{-}1 + (R^*T\text{-}1 - R^0t\text{-}1 / R^*T\text{-}1 - R^0t\text{-}1)\ R^*T\text{-}1$

For The Computational Efficiency, When ($X^*T\text{-}1$, Xt^0) Is Than *T3* ($T3 < T2$), We Terminate The SCS Process And Directly Map $X^*T\text{-}1$, Xt^0 Without The Linear Prediction Method.

III. Experiments

In This Section, We Compare The Performance Of Our Technique With The Conventional Techniques. In The Implementation Of The Proposed Algorithm, We Convert The Floating Point Operation To The Integer Operation. In Addition, Time-Consuming Operators Such As Trigonometrical Function And The Square Root Function Are Calculated In Advance And Tabulated.

The Color Accessibility In The Image-Level Is Evaluated. The *NAT* Indicating How Much Distortion Occurs Through The Recoloring Process Is Calculated By,

$$NAT = \frac{1}{\eta(O1O2)} \sum_{Xoeft} \left\| X^0 - X^{\cdot 0} \right\|_2$$

Where *N(A)* Is The Number Of Elements In The Set *A*. The Smaller *NAT* Indicates The Better Preservation Of The Color Information.

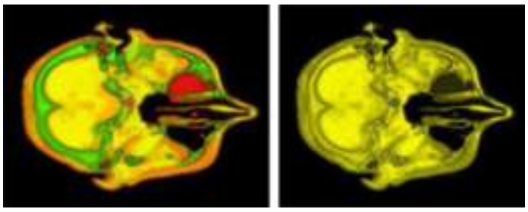
TABLE I NUMERICAL COMPARISON OF IMAGE-LEVEL QUALITYMETRICS

Image	Resolution	Processing Time(Sec)	NAT
Brain	235 * 215	7.103870	19.8017
Gaugin	369 * 294	12.130848	19.4673
Snow	320 * 158	10 .079801	14.9938

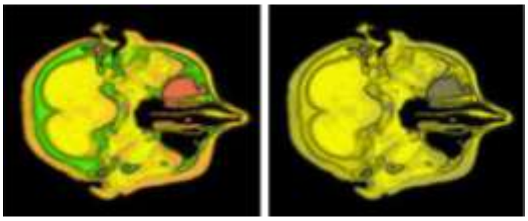
Hockey			
Vegetable	670*273	15.159256	57.3348

Here, Table Shows Numerically Computed Value Of NAT. It Indicates That The Recolored Images Are Natural Enough In Comparison With Original Image. The Results Are Obtained By Using Laptop With Corei7 And 12GB RAM.

a) Image Recoloring Results



(a) (B)



(b) (D)

Figure 4 : (A) Original Image Brain.Png

(b)Original Image Seen By CVD (C) Recolor Image
(d) Recolor Image Seen By CVD.

(a) (B)

(C) (D)

Figure 5 : (A) Original Image Gaugin.Png (B) Image Seeen By CVD (C) Recolor Image (D) Recolored Image Seen By CVD

TABLE II NUMERICAL COMPARISON OF COMPUTATIONALCOST

Video	**Resolution**	**Duration (Sec)**	**Processing Time (Sec)**	**FPS**
Cricket	1280*720	7	1011.5	30
Basketball	640*360	10	404.2	30
Django Unchained	640*360	10	345.5	30

Football	640*360	30	195.9	5

We Have Calculated The Computational Complexity Of The Proposed Method. Comparison Results Are Represented In Table II.

b) Video Processing

Frame10 **Frame 20** **Frame 30** **Frame 50** **Frame 70** **Frame 77**

Figure 6 :Testing Performed On The Basketball.Avi Video Using Proposed Method.(A) Original Video Frames, (b) Shows Original Frames Seen By CVD,(C) Shows Recoloured Frames,(D) Recoloured Frames Seen By CVD.

Frame 10 **Frame 60** **Frame 159** **Frame 294**

Figure 7 :Tesitng Performed On The Django Unchanged.Avi Video Using Proposed Method.(A) Original Video Frames(B) Original Frames Seen By CVD(C) Recolored Frames(D) Recolored Frames Seeen By CVD.

IV. Conclusion

The Algorithm That Considers Floating Point And Uses Matrix Calculation And Also The Algorithm That Uses Neural Networking Concept Are Time Consuming. The Clustering Algorithm Are Suitable Only For Some Colors. The Proposed Method Is Fast Color Modification Method For Colorblind. RGB To LMS Algorithm Is Used To Maintain Temporal Color Consistency Of The Re-Colored Video Sequence In Addition

To Spatial. The Proposed Method Has Low Computational Complexity. TCC Is Maintained Local Color Contrast Is Also Maintained. This Will Be Very Useful For The People Who Are Suffering From Color Blindness As They Will Have Access To Information As Well As Enjoy The Video.

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