**Operating ColorCube**

ColorCube, JF Sather 6/06/2014, View and select colors in the context of an RGB color cube.

Help Note: There are nearly identical Coarse and Fine Mode overviews that can be viewed by pressing the Help key at any time during execution of ColorCube. The overview is displayed for the active mode when Help is pressed.

Program Notes:

ColorCube is heavily commented. I use Erwin Ried's PrimePad to strip off the comments of the in-Calculator program. <http://www.hpmuseum.org/forum/thread-36.html> . A number of the comments cause syntax errors in the calculator and need to be removed or repositioned before the commented version would actually compile.

The Help subroutine is at the end of the program and not needed once you achieve basic familiarity. You can reduce program size several K by deleting everything between BEGIN and END; in the Help Subroutine. Pressing Help will then do nothing.

ColorCube is updated to operate with the current HP Prime firmware release 6030/6031.

This was my learn-to-program-the-HP' project. Be forewarned, I probably broke all the rules.

**General**

The possible colors of an RGB Pixel can be thought of as a color cube with edges aligned on red, green, and blue axis. ColorCube draws the color cube in slices, and allows you to navigate about and select colors within the context of the color cube.

The HP' has a 16-bit display panel with five bits per color giving 32 possible values for red green, and blue for each pixel. This is equates to 32^3 = 32768 possible colors per pixel. By convention, RGB colors are listed with value 0-FFh for each color. The HP' truncates the three LSBs of each color so that e.g. A9, AA, ..., AF are all truncated to A8, and A8 will be returned by the GETPIX\_P commands if a pixel was set to any of those values. ColorCube lists all RGB values in truncated (or true HP' form) with the minimum difference between two color values as eight.

Color cube displays color slices in two possible modes, coarse and fine. Coarse Mode displays the entire color cube in up to 9^3=729 colors. Fine Mode displays three partial slices of the color cube surrounding the currently selected color. The Fine Mode color difference within and between the partial slices is selectable and designated by Color. Directly after ColorCube compilation, the slices in either mode vary Red by Blue within the slice and by Green between the slices. In other words, blue, red, and green are the x, y, and z-axis assignments by default, but this is easily sequenced among the six possibilities by touching the color indication triangles in the upper left corner. In either mode, the screen area consisting of all the displayed slices is referred to here as the **palette**.

Coarse Mode is entered by touching any of the six buttons at the bottom of the display. Fine mode is entered by touching any of the three color bars in the upper right, Reference, Selection, or History.

ColorCube can be utilized as a color selection tool, a "color picker", or as a tool for studying RGB color space. In Fine Mode, especially with Color set to small values, you can navigate through space within the color cube a little like being in a Harry Potter 3D elevator.

**Coarse Mode**

When ColorCube is first run, it begins in Coarse Mode displaying three slices of 9 colors each. These are the "Main 27" colors. Conceptually, the RGB color cube is sliced into three cross sections and displayed. By touching any of the six buttons at the bottom of the display, you may choose Coarse Mode palettes of 8, 27, 64, 125, 216, or 729 colors (all powers of 3). The colors are evenly spread out in 3D space as nearly as dividing 31 into groups allows.

To select a color and return it, choose a palette size and touch the desired color to make a circular cursor appear. You can move the cursor within the palette using the up, down, left, right keys and move it in the z-axis (from slice to slice) using the Plot and View keys. As you move the cursor, the Selection color bar in the upper right displays the color of the cursor location. If you press the Enter or Esc key, ColorCube will exit and return the Selection color. For example, enter the following in the Home command line to select a color using ColorCube and draw a triangle in that color:

rect;triangle\_p(0,239,159,0,319,239,ColorCube);wait

With 64 display colors or more, there are two or more rows of slices displayed. These increase in z-axis color value from left to right and top to bottom, the same as with English written text. Pressing up, down, left, right, Plot, or View will increase or decrease the cursor color value by the same color increment so you can see the effect of changing a color by the same amount of red, green, or blue. Sliding and swiping in the palette area is inactive in Coarse Mode.

Coarse Mode redraws proceed in the background and can take a second or so with 729 colors. Little dots are drawn across the bottom right during Coarse Mode redraws to indicate that ColorCube is still working, even though nothing seems to be happening on the screen.

**Fine Mode**

Touch any of the Reference, Selection, or History color bars in the upper right to initiate Fine Mode centered about the color touched. The display is of 27 colors like the 27 color Coarse Mode palette, but the difference between adjacent colors is only 20h (compiler preset) like the 729 color Coarse Mode palette. The difference between adjacent colors is designated as Color and it can be adjusted in Fine Mode to any value from 8h to 60h in steps of 8.

In Fine Mode, the cursor is always present and Selection always indicates cursor color. The up, down, left, right, Plot, View keys move the cursor the same as in Coarse Mode except that when the cursor is at an edge (or outside slice for Plot / View) and is pushed further in that direction, the entire display shifts by the amount Color. This display shift is visible in the palette color, in the Selection color bar, and in the text surrounding the palette describing the R,G,B colors for each row, column, and slice .

In addition to the key movements, you can drag the palette in the x,y plane with your finger by beginning the drag motion in the palette area or in the z-axis by beginning the motion in the **Z-axis Color Bar** beneath the middle slice of the palette. If ColorCube detects a swipe or flick in these motions, it will send the palette to the indicated extent of travel, 0 or F8h. To get a feel for these motions, set Color to 8 and drag you finger vertically or horizontally beginning in the palette area or horizontally beginning in the Z-axis Color Bar while viewing the Selection value. You will be able to see the red, green, or blue portion of the Selection value vary with the associated finger motion.

Beneath the palette area are three indicator / control color bars, the Color, Z-axis, and Brightness color bars. The **Z-axis Color Bar** in the middle is painted in the z-axis color, red, green, or blue as selected by touches in the upper left corner of the display. To its left and right are similar Color and Brightness indicator / control bars. These three bars respond to touch, drag, or swipe motions as follows: Touch left or right side of bar to decrement or increment value by minimum amount. Drag left or right to decrease or increase value in increments of the minimum amount. Swipe left or right to send the value to its extreme excepting Brightness which is described below. The left and right touches function identically to key presses indicated in the bars.

**Color** controls the difference in color between adjacent colors and slices and the amount of travel between displayed palettes as you navigate about the color cube. Color varies between 8 and 60h and is actually the minimum increment of the z-axis bar to its right. 60h is a little large for navigation, but it allows you to see some strong definition between adjacent colors in Fine Mode. Color is preset to 20h when ColorCube is compiled, but afterwards it remains where you set it when you leave and enter Fine Mode.

The **Brightness** (or gray scale intensity) bar is meant to show the effects of subtracting and adding brightness to a selected color by multiplying the R,G,B values each by the same factor. These factors vary in increments of 2^(1/4) meaning 2^(-1/4), 2^(-2/4), 2^(-3/4), ... decreasing and 2^(1/4), 2^(2/4), 2^(3/4), ... increasing. If you swipe the Brightness bar vs. dragging, the factor will skip to the next integer power of 2 such as ...1/8, 1/4, 1/2, 1, 2, 4, 8. When you first modify the Brightness factor from 1, Selection is stored at History and the product FxH becomes the Selection. In other words, let S0 be Selection when Brightness is first changed from 1 and Si be current selection as modified by Brightness factor Fi, then Si = Fi x S0. To return Selection to its original value S0, use the Brightness bar to return its factor to 1 or just touch the History bar.

Current values of Color and Brightness factor are displayed within the color bar, but the finger obstructs your view of these during drag or swipe motions. For this reason, these values are momentarily displayed near the top of the screen while they are being modified by drag or swipe motions.

Firmware release 6030 reacts to a fast swipe or flick motion by sending a series of drag indicators that last about a second unless the operator touches the screen to interrupt them. While ColorCube is waiting for this second to time out, it draws a series of dots across the top left of the display as a signal to the operator that a swipe was detected.

To return to Coarse Mode, touch one of the buttons along the bottom of the display. You can return to the previous Fine Mode selection by pressing Selection before placing the cursor in Coarse Mode or History after placing the cursor.

**Common Features of Course and Fine Modes**

The following descriptions are generally true in both Fine and Course Mode with exceptions as noted.

**Z-axis Indicator / Touch Control**

Along the top of the display are touch / slide indicators common to both Coarse and Fine Modes. At the far left is the Z-axis indicator that gives a quick indication of the axis color assignments. Touching the panel in this area sequences through the six possible x,y,z axis assignments. This has a benefit in color picking as the colors group differently in case you are looking for a violet, or an aqua, or a tangerine, etc.

**Outlines Indicator / Touch Control**

The Outlines indicator lets you highlight certain colors of interest, namely the cursor color transpositions, Main 8, Main 27, or the Grays. The transpositions are the other five colors you would get by rearranging the red, green, and blue values. The transpositions have nearly identical brightness since the sum of the R,G,B values is the same. The transposition outlines are active only in Coarse Mode and only if there is a cursor visible in the palette area.

The Main 8 and Main 27 and Gray outlines indicate where these common colors are located on the larger Coarse Mode palettes or if they happen to be on a Fine Mode displayed slice. The 8 colors of Main 8 are the possible colors using 0 and F8h for R,G,B. The 27 colors of Main 27 are the possible colors using 0, 80h, and F8h for R,G,B. The Gray colors are simply those in which the R,G,B values are equal to each other.

**Reference, Selection, History Indicator / Touch / Slide Controls**

The Reference, Selection, and History color bars serve specific purposes but have the common feature that if you touch one, you enter Fine Mode centered about the color of the box that you touched. Also, If you touch Reference or History, that color is transferred to Selection. You can actively transfer the colors between these three boxes as follows:

Reference -> Selection: Touch Reference (initiate Fine Mode centered about the Reference Color)

History -> Selection: Touch History (initiate Fine Mode centered about the History Color)

Reference -> History: Slide Finger beginning in Reference in any direction

History -> Reference: Slide Finger beginning in History in any direction

Selection->Reference: Slide Finger beginning in Selection toward the left

Selection->History: Slide Finger beginning in Selection toward the right

**Reference** displays the value of the global variable, Ref. This is a color that can be set prior to calling ColorCube as a color for comparison or any other reason. Reference does not change in the course of operating ColorCube unless you purposefully change it by sliding Selection or History to Reference. If you place a value such as #123456h in Ref and call ColorCube, then #123456h is displayed in the reference window. If you then touch Reference or slide it to History, the value passed is #103050h. The HP' displays #123456h identically to #103050h, and it truncates #123456h to #103050h as can be verified with the GETPIX\_P command. ColorCube is just simplifying things to HP' reality.

**Selection** displays the value of the variable Sel which is returned by ColorCube to any calling program when Enter or Esc is pressed or to Ans if called from the command line. Selection varies with cursor location and can be keyed in as described below in **Key Functions**.

**History** is like Reference in that it is useful for comparisons, but it is not the value of a global variable and is sometimes automatically updated to Selection as a means of referencing or returning to that selection. The value of Selection is automatically transferred to History 1) anytime you touch the palette area, placing the cursor and 2) in Fine Mode when you first increase or decrease brightness by sliding or touching the Brightness control bar. Because of the automatic modifications to History, you should slide any History color you may need to recall over to Reference for safe keeping.

**Key Functions**

A limited number of HP' Keys have special functions in ColorCube. These are listed below. Any other key press takes you to an input box where you can input a color, usually in #rrggbbh or RGB(R,G,B) format. This color goes to the Selection window with three LSBs stripped off for each color. If you were in Fine Mode prior to keying in the color, you will return to Fine Mode centered about the color that was keyed in. If you were in Coarse Mode, you will return to Coarse Mode with no cursor placed. Then you can press Enter to exit ColorCube and return the value you entered. Or you can select any Coarse Mode palette size then touch the palette area to place the cursor and save the keyed in value to History. You can also just swipe the value you entered left to Reference or right to History and proceed.

The special purpose keys are as follows:

Enter or Esc: Exit ColorCube and return Selection

Up, Down, Left, Right, Plot, View: Move Cursor and Fine Mode partial slice

-, + Keys: Decrease, Increase Color (Fine Mode only)

Num, Menu Decrease, Increase Brightness of Selection Color (Fine Mode only)

Help Present Coarse or Fine Mode overview depending on active mode

On Interrupt execution of ColorCube

Touching the left or right side of the Color, Z-axis color, or Brightness bars in Fine Mode performs identical functions to the -/+, Plot/View, and Num/Menu Keys respectively.