ColorCalibration

Software for color calibration of Sony Aibo robots in a RoboCup environment

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USER MANUAL

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1 Introduction

ColorCalibration is developed with a RoboCup environment in mind but can be reconfigured for other color calibration needs. It will let you calibrate a color table for use with your Sony Aibo robot with little effort. It provides powerful tools to view, modify and automatize the calibration.

Previous experience with Sony Aibo robots, RoboCup and Open-R programming is assumed throughout this user manual.

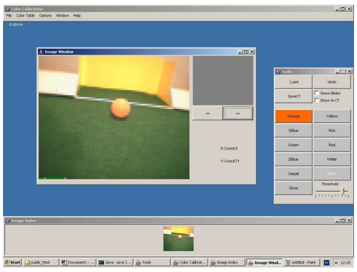
If you are a first time user please browse through the Quickstart section of this manual to get started as soon as possible.

Thank you for choosing ColorCalibration.

1.1 Quickstart

Install the program files in a directory. Start up the ColorCalibration program with:

```
java ColorCalibration
```



X-Coord:9

Y-Coord:71

When the program is running, click the “Load” button in the toolbox to open up the load file dialog. Select the *quickstart.kji* image included in the ColorCalibration distribution and click load. The image is loaded and displayed as a thumbnail in the image index window at the bottom of the screen. Single click on the image to open it up in an image window. Your screen should now look something like the screen pictured to the left.

Select some pixels from the ball by clicking on them in the image window, and watch how the segment grows. Select other colors from the toolbox and try to make the segmented image as good as possible. If you make a mistake, you can always click “Undo” to delete your last selection. But remember that the undo function works with channels, one for each color, so you have to be in the right color in order to undo. There are twenty steps of undo in each channel.

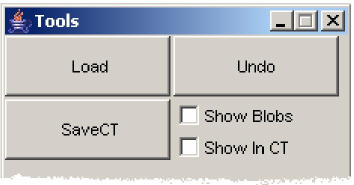
When you are satisfied with the segmentation, click the “Save CT” button in the toolbox to save your color table. Just press ok when the program asks for suffix.

ColorCalibration is so much more, but you should now have a general idea of how to calibrate your Aibo!

2 Working with ColorCalibration

2.1 The Toolbox

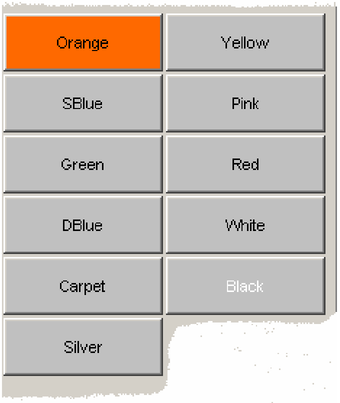
Here you will find the most commonly used tools and operations. The toolbox resides in a window of its own, and can easily be placed anywhere on the screen you find convenient.



Load – Opens the load image dialog which lets you select and load one or more images from the hard drive or directly from your Memory Stick reader. Images loaded are displayed in the image index window on the bottom of your screen.

Save CT – Opens the save color table dialog which lets you specify a filename and path to save the color table. You will be prompted for how to label the color table arrays, just press ok to save it as “generic”. For more information on the format color tables are saved in, please see 3.3, *Color Table file format.*

Undo – Enables you to erase your last selected pixel from your color table. Undo works with channels, so only pixels selected in the color currently active is erased. To undo a selection in another color, simply select that color in the toolbox and press undo the desired number of times. There are twenty steps of undo in each channel. Please note that the results from undo will not be visible until the image window is in focus. Undo effects all images, not just the one(s) currently displayed.

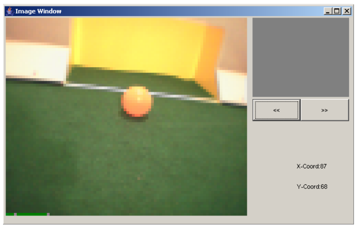


Show Blobs – Checking this option displays all the images in the index window as segmented. This is a great way to get an overview of how good your color table is at the moment. Please note that keeping this option checked at all time might drastically reduce program performance.

Show In CT – Checking this option lets you click a pixel in an image and see where in the color space it is located. This is a powerful tool to find stray pixels in your color table.

Color palette – Clicking on these selects which color you are currently working with. The button is colored in the active color. This also affects which undo channel is used.

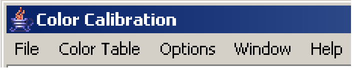
Threshold – This slider shows the threshold value for the current color. Just drag it to change the threshold. Thresholds affect how many pixels will be included when growing the segments. Thresholds are saved with the color table.



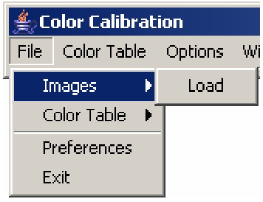
2.2 Image window

The image window is the main working window. In this window you click to select pixels (color values) to be included in your color table. The small display to the right in the window shows the segmented version of the image. Clicking on the buttons with arrows displays the next/previous image.

2.3 Menus

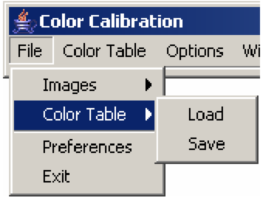


The menus contain many options not available anywhere else in ColorCalibration. There are five main categories: File, Color Table, Options, Window and Help.



File – Images – Load – Opens the load image dialog which lets you select and load one or more images from your hard drive or directly from your Memory Stick reader. Images loaded are displayed as thumbnails in the image index window on the bottom of your screen. Single click on a thumbnail to open it up in a new window.

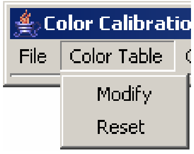
File – Color Table – Load – Opens the load color table dialog which lets you load a previously saved color table.



File – Color Table – Save – Opens the save color table dialog which lets you specify a filename and path to save your color table. You will be prompted for how to label the color table arrays, just press ok to save it as “generic”. For more information on the format color tables are saved in, please see 3.3, *Color Table file format*.

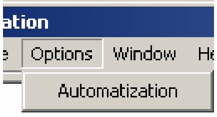
File – Preferences – Opens the preferences dialog. For more information on preferences settings, please see 2.7, *Preferences*.

File – Exit – Exits the program.



Color Table – Modify – Opens the color table window. This lets you see how the color values in your color table are distributed in the color space. For more information on how to work with the color table window, please see 2.5, *Color Table*.

Color Table – Reset – Resets the color table. Please be careful with this function. You must undo for all the color channels to get your color table back.



Options – Automatization – Opens the automatization window. For more information on the automatization process, please see 2.6, *Automatization*.

Window – Show Toolbox – Opens the toolbox window if it is not already on open.

Window – Show Image Index – Opens a new image index.

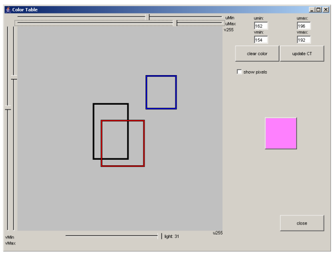
Help – Help – Shows this manual.

Help – About – Shows info about ColorCalibration.

2.4 Image index

The image index window shows small, thumbnail size, versions of all images loaded. Images can be displayed as regular images or segmented ones, based on the current color table. Just check “Show Blobs” in the toolbox to show segmented images. Please note that updating many segmented images might drastically reduce program performance.

2.5 Color table

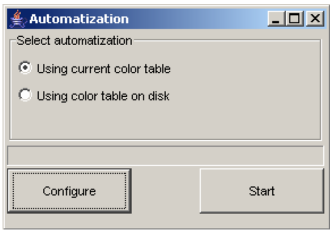


The color table window shows how the color values in the images loaded and in the current color table are distributed in the YUV color space. There are 32 levels of Y (light), which one is displayed is indicated by the “light” slider. For each Y value, the U and V values in the current color table are shown by a box in the color space area. If the “show pixels” option is checked, all color values that are actually in the images are also plotted in each box, with darker colors representing a higher density. Boxes showing the color value boundaries may overlap each other, and in that case the color with the highest priority takes precedence. The colors are ordered in the same order they are displayed in the toolbox palette, with the default order being orange, yellow, sky blue, pink, green, red, dark blue, white, carpet, black and silver where orange has the highest priority. Priority rules are the same for the "show pixels" option, in case of overlapping.

When the mouse is moved around in the color space area the color directly under the mouse pointer is displayed to the right. Also displayed to the right are the actual U- and V values for the color currently selected. The button "Clear color" clears the color boundaries for the color currently selected and only for the current Y (light) value. At all times you need to press the "Update CT" buttons for the changes to take effect.

Clicking the button "Close" closes the color table window.

2.6 Automatization

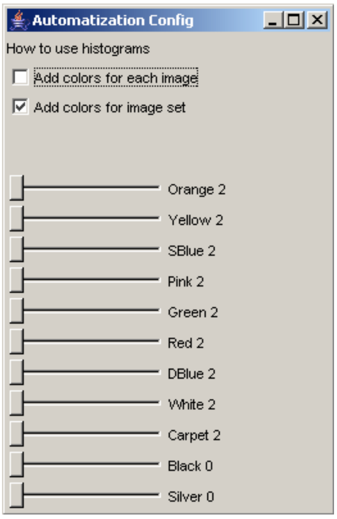


Select automatization

● Using current color table

○ Using color table on disk

The automatization window lets you specify whether to run the automatization process with the current color table or one loaded from disk. Clicking "Configure" lets you specify how many color values to select during the automatization and if you want to use local histograms (e.g., one histogram for each image and color values are selected from each) or global histograms (e.g., one histogram for the entire set of images to select color values from) or both. It also lets you specify how many color values of each color you want to add to you color table. Note that a low number of values are recommended if using local histograms. With the global histograms a larger number is probably better.



How to use histograms

☐ Add colors for each image

☑ Add colors for image set

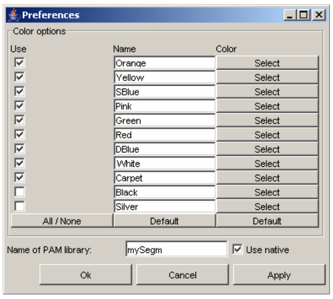
Orange 2
Yellow 2
SBlue 2
Pink 2
Green 2
Red 2
DBlue 2
White 2
Carpet 2
Black 0
Silver 0

A good way to automatize the calibration is to run the automatization first, getting a low number of color values from each image and then run it again, getting a high number of color values from all images. This will generate color values for most objects.

Experiment to find values that work for your type of playing field and light conditions.

The automatization process needs a large set of images to be effective.

2.7 Preferences



Use	Name	Color
☑	Orange	Select
☑	Yellow	Select
☑	SBlue	Select
☑	Pink	Select
☑	Green	Select
☑	Red	Select
☑	DBlue	Select
☑	White	Select
☑	Carpet	Select
☐	Black	Select
☐	Silver	Select
All / None	Default	Default

Name of PAM library: mySegm ☑ Use native

The preferences window lets you set your colors and their names. It also lets you check/uncheck colors. Unchecking a color makes ColorCalibration ignore the color for all processes, e.g., segmentation and automatization. However, you are still able to select pixels from an image with an unchecked color; it just won't show in the segmentation.

Preferences also lets you specify a system library that contains segmentation routines, if you want to use your own segmentation routines. Just specify the name, and make sure the systems library path environment variable is set to where the segmentation library is located and check the option "Use native" to use your own segmentation routines. You can read more about native segmentation routines in Chapter 4, *Using native segmentation code*.

3 Working with files

There are a few file formats you need to be familiar with, to get the most out of ColorCalibration. Here is a short description of the file formats.

3.1 PGM file format

The PGM file format is the format of the tutorial Open-R program *Image Capture*. It is divided in three files; the Y-, U- and V component. No compression

3.2 KJI file format

The KJI file format is, unlike PGM, a one file per image format. It is a YUV format and bears a close resemblance with the PGM format. No compression.

3.3 Color Table file format

The color tables are saved as C++ source code, giving you the ability to just include one when you compile your Open-R source code. Example:

```
#define TableSize 32

const unsigned char red_generic[TableSize*4]= {
      127, 127, 127, 127,
      …}
```

3.4 Converting PGM files to KJI files

To convert image files created for example by the Open-R tutorial program *Image Capture*, a batch conversion tool is included in the ColorCalibration distribution. It is a stand-alone application that can be run either as a command line application or with a graphical interface. It is called *FileConverter*. To use FileConverter in command line mode, just run it like a normal java program with your Y images as parameters. Example:

```
java FileConverter Yimg00.pgm Yimg01.pgm
```

To use FileConverter in a graphical environment, just run it without any parameters and a file selection dialog is displayed, letting you specify files to convert.

The files converted are saved in the same directory as the PGM files.

4 Using native segmentation code

ColorCalibration gives you the ability to run your own segmentation routines, written, for example, in C or C++.

4.1 Why use native code?

Why use your own code when ColorCalibration provides built-in, robust segmentation routines? The reason is simple. Calibration is done in order to make the segmentation optimal. If you are not using the same segmentation on your Aibo robot then you can not be sure the color table made with ColorCalibration is the optimal one. This does not mean that using the built-in segmentation is a bad idea. It is based on the latest segmentation routines from Team Sweden used successfully in RoboCup. But for serious Aibo applications we strongly recommend using your own routines.

4.2 Compiling the code to work with ColorCalibration

In order to use your own segmentation routines in ColorCalibration, you first need to compile your segmentation code into a system library with a small ColorCalibration wrapper included. A wrapper working on Team Sweden's segmentation routines is included in the ColorCalibration distribution. Modify it to work with your segmentation code and compile it. Example for linux:

```
g++ -I/usr/java/jdk1.4/include -I/usr/java/jdk1.4/include/linux -fPIC Segm.cc –c
g++ -shared -Wl,-soname,libMySegm.so -o libMySegm.so Segm.o
```

Where *Segm.cc* is your segmentation routine with the ColorCalibration wrapper included:

```
#include "AiboImage.cc"
```

The wrapper contains three methods. You may not change the input or return parameters of these methods. But you may freely alter the methods to fit your segmentation code.

```
/* set the image from Y-, U- and V-arrays */
jint Java_AiboImage_setImage(JNIEnv*, jobject, jintArray, jintArray, jintArray);

/* set the threshold from an array of thresholds */
jint Java_AiboImage_setThreshold(JNIEnv*, jobject, jintArray);

/* get the segmentation from array with colors indexes matching color table */
jintArray Java_AiboImage_getSegmentation(JNIEnv*, jobject, jintArray);
```