A Symbolic Approach for Colorimetric Alterations

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Abstract

To modify colours, many solutions are possible. Here, we present an approach that uses symbolic linguistic modifiers. Colours are modified thanks to two kinds of words: a modifier and a qualifier. The first one is translated into a symbolic linguistic modifier whereas the second one into one or many fuzzy subsets. In fact, we can say that we associate words with these two kinds of simple mathematical objects.

Keywords: Alteration in colorimetry, linguistic modifiers, fuzzy logic, colorimetric qualifier, symbolic approach.

1 Introduction

In this paper, we present an original way to alter colours based on a symbolic approach thanks the use of linguistic modifiers, those defined by H. Akdag, A. Borgi and N. Mellouli. These modifiers allow small variations that we apply on the colour itself (i.e. on its colorimetric components). To express the alteration of the colour we also need qualifiers as *vivid, dark, etc.* Thanks to these two terms (the qualifier and the modifier) the altered colour can be performed.

A good choice of colour is a problem, which has always concerned a lot of persons. For example, people who want to choose their wallpapers or their paint's colour in order to obtain a beautiful harmony are interested in this problem. In these cases, some adapted software that would help users to find the right colour thanks to words stemmed from the common language would be useful. We can imagine different strategies for this piece of software. A first one would be to let the user choose among a very large quantity of colours the one he wants. But everybody knows that it is very difficult, even impossible to make the right choice when we have a huge quantity of information. A second strategy would be to propose to the user to choose an initial colour and to allow him to change slightly this colour thanks to simple words. In fact, we would need two sorts of words: a modifier and a qualifier.

The concept of modifiers has been studied for several years in the fuzzy logic context [9] [5]. Modifiers expressed by means of fuzzy linguistic variables have been notably used in expert and decision-making systems because they are easy to use and can provide simplified inferences [3], [4].

In this work, we show how linguistic modifiers, in sense of [1] can be useful for our problematic. In section 2 we describe in detail the way we analyse the problem in colorimetry. After a short reminder of symbolic linguistic modifiers that we use, section 3 explains how to employ them in our context. Finally, section 4 concludes this study.

2 Problem analyse

2.1 Introduction

To be able to propose colour alterations, we place two kinds of terms at the user's disposal: a modifier as *a bit more, much more, less, ...* and a qualifier as *dark, intense...*and we place a set of basic colours corresponding to eleven direct chromatic appellations. If it is not enough, the user can choose another colour among the 16 million available.

The principle consists in applying both terms on the colour components (since a colour is coded through three colorimetric components Red, Green, Blue in RGB-space): we have to modify the values of the components. But RGB-space is not a convenient space to express notions of lightness (e.g. qualifier *dark*) or intensity (e.g. qualifier *intense*)... That is why the first step of our work is to move from RGB-space to HLS-space (Hue, Lightness, Saturation-space), which is much handier than RGB-space. This colorimetric space is based on systems used by artists: it allows us to express a colour in a very intuitive way.

2.2 Colorimetric qualifiers

Colorimetric qualifiers may affect the colour by three ways (at least): altering Hue (H), altering Lightness (L), altering Saturation (S) (and also by altering more than one component at a time).
For the qualifiers depending on L and S and after expertise [7], we have decided to distinct 15 different cases, as shown in figure 1.

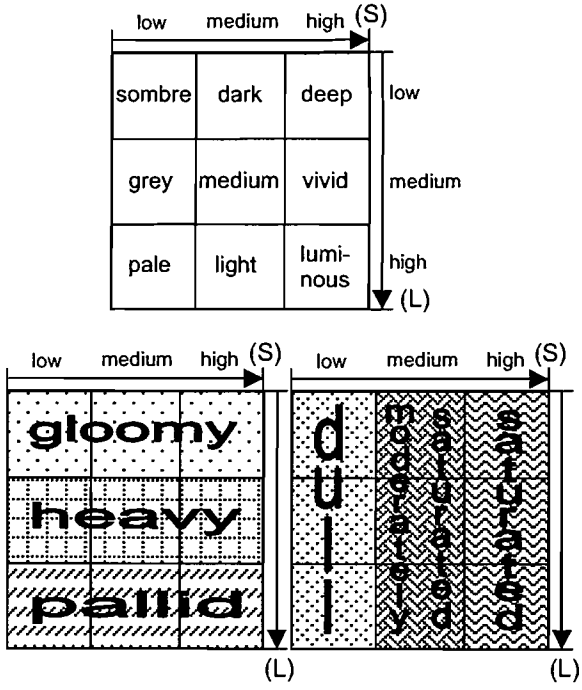

Figure 1. The 15 colorimetric qualifiers hanging on L and S.

As for the qualifiers depending on H (e.g. bluish, orangey, ...), we have decided to express them through the concept of fuzzy membership functions.

After an exhaustive study and as [6] do, we obtain the following diagram (cf. figure 2):

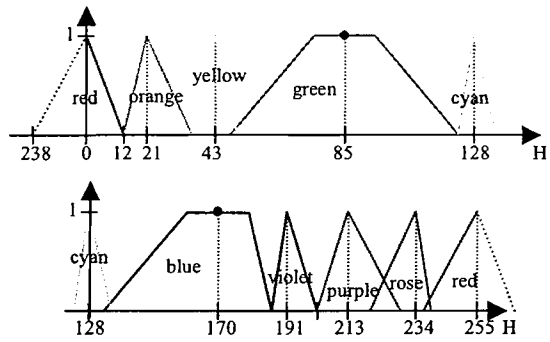

Figure 2. Fuzzy membership functions for the nine principal direct chromatic appellations (black and white and not represented, since their hues are undefined) for H in HLS-space.

In this particular case where qualifiers depend on H, and unlike qualifiers depending on L and S, we use the concept of alpha-cuts defined in [2, p23] to express alterations.
It is the only way to obtain correct results to our eyes perception.
Thus, we can easily define n α-cuts on the membership functions for H component. For example, if we consider the value "blue", α_0 corresponds to "a little more blue", and α_{n-1} to "enormously more blue" (cf. fig. 3 below).

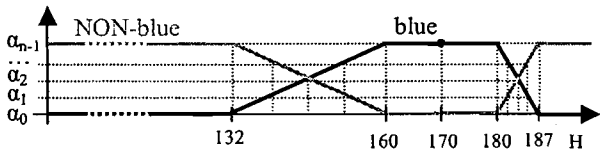

Figure 3. α-cuts associated to fuzzy membership functions for H component, when H corresponds to blue and NON-blue.

3 Using symbolic linguistic modifiers

3.1 Short reminder

Symbolic linguistic modifiers have been proposed by Akdag & al in [1].
A modifier m is defined such as: $(a',b') = f_{m(q,n,m)}(a,b)$ with a corresponding to a symbolic degree (a' the modified degree), b a scale base (b' the modified scale base), q the strength of the modifier, n the nature (i.e. dilatation or erosion) and m the mode (reinforcement or weakening).

Formally, Akdag & al associate to each linguistic degree D of range a on a scale b an intensity rate

$$Prop(D) = \frac{a}{b-1}$$

The formal definitions of the modifiers and a comparison between them are gathered in figure 4.

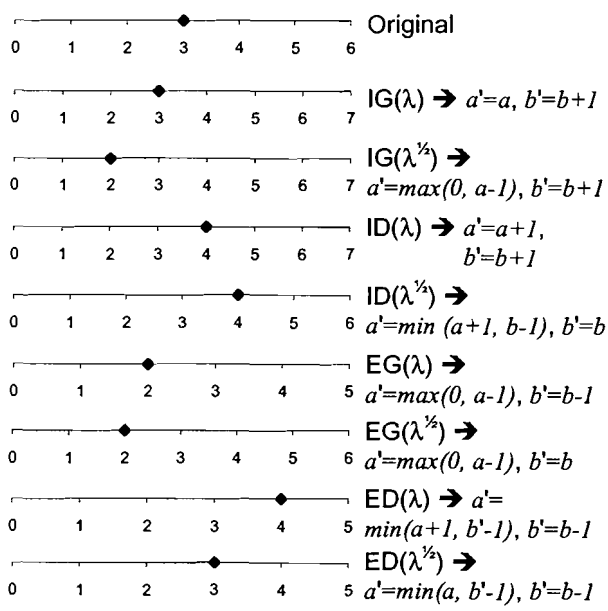

Figure 4. Definition and comparison of symbolic linguistic modifiers

3.2 Compound linguistic modifiers

The modifiers introduced in section 3.1 are basic elementary modifiers because from a symbolic value we obtain a neighbouring value in the same or in the neighbouring bases. Now, in our application, we need to express many slight moves from a value to another. That is why we have had the idea to create new modifiers, more sophisticated, obtained by composition (in the mathematical sense) of the first ones. We have called them SLVs (Symbolic Linguistic Values) because they represent for our problem a modifier as *much*, *a bit*, *a little bit*, etc. We have constructed seven SLVs that you can see in figure 5.

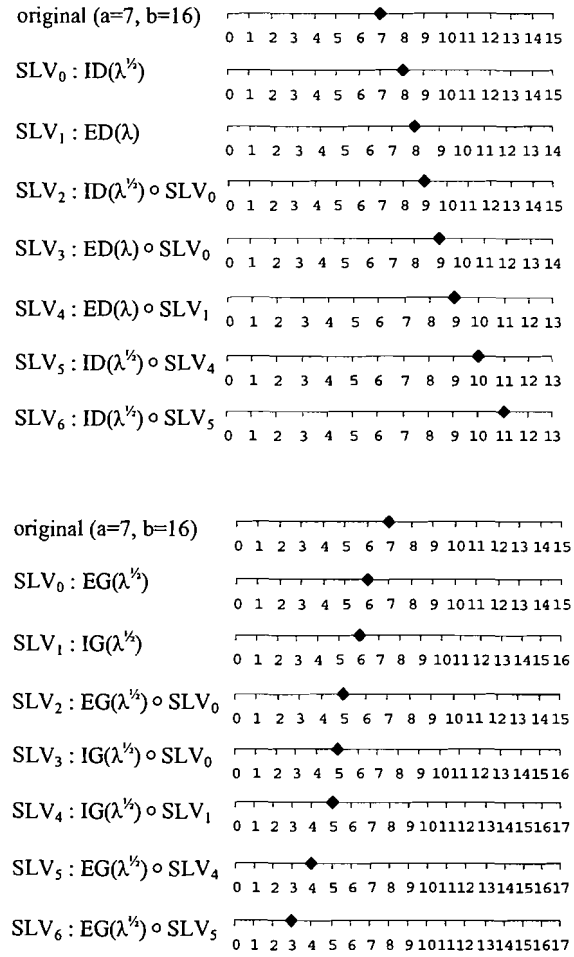

Figure 5. SLVs representing reinforcement and weakening of the initial value.

For example, SLV_0 can be associated to the words: *a little bit*. If we want to increase the original value, we will use $ID(\lambda^{½})$ for the computation and the associated expression will be *a little bit more*.

More details about the choice of the symbolic linguistic values introduced by Akdag & al are available in [8]. Notably, we introduce other compound modifiers that allow smaller moves than those performed in figure 5.

To sum up the algorithm employed to carry our piece of software out, let us have a look at figure 6 which illustrates the process:

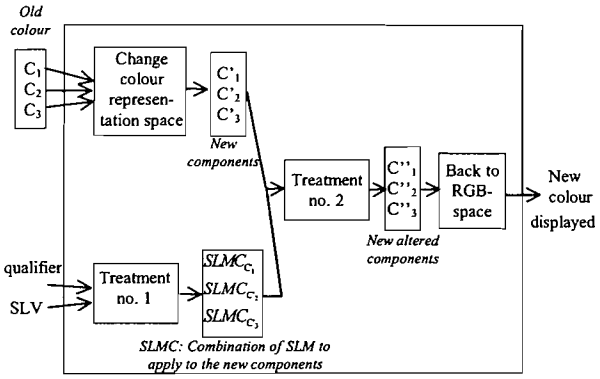

Figure 6. Main algorithm for colour alterations using compound symbolic linguistic modifiers.

4 Conclusion

We have shown how we could use symbolic linguistic modifiers in a framework of colorimetry. We need to alter these original modifiers slightly in order to obtain more gradual modifiers. Practically, results obtained are rather good since the satisfaction degree of the expert is about 84%. A comparison with other methods will be done soon.

It would also be interesting to use another colour-space than HLS, a Uniform Colour Scales space, for example, which is a colour-space that respects human perception. We could replace our colours membership functions by using these kinds of spaces (CIELab is one of those).

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