Extended abstract

Dyeing and finishing, being an end of the line process for a textile, traditionally bear a large proportion of the cost of faults. In order to minimize customer rejections and returns, dyers and finishers are forced to suffer the high labor costs associated with detailed manual inspection. And manual inspection is not always a guaranteed solution to the problem. Computer vision systems are large and complex, typically involving multiple planes of cameras with several cameras on each plane and numerous lighting arrangements. The operation of such machines has, in the past, been an unwieldy task. Traditionally, the process of setting up such systems has been long and arduous with multiple sets of parameters needing to be set for each differing material, color, customer or batch number. Such number of parameters together with variability of present day cameras and the technologies available on the market today vary widely. Based on that, VÚTS has developed a new color sensor for the on-line textile quality control system focusing on high traceability of measured data between on-line and off-line measuring systems. This paper describes the features of this color sensor and deep analysis of factors influencing measured colorimetric data.

Keywords: Colorimetry, on-line color measurement, quality control, textiles

Introduction

In-line color monitoring, properly configured and used, can produce substantial savings in dyeing and finishing operations. When continuous dyer has to make an adjustment to correct a shade variation, it would be of great benefit for him to know whether the change had originated on or before the dye range. Such work would be the part of a larger study to help the continuous dyer to rapidly distinguish between the color variations which he can control and those which he cannot.

Some companies utilize on-line systems for measuring and, in some cases, controlling color. Because of this movement, there are ever-increasing opportunities to compare in-line and laboratory measurements. Since a number of companies produce both laboratory and in-line systems for different industrial applications such as pulp and paper, food industry, we get a lot of questions related to why lab and
on-line measurements don’t agree. There are several reasons for which the instruments can disagree; yet each reading is, in itself, “correct”. What are those reasons? The geometry differences between sensors, product backing difference, calibration basis difference, product condition difference at time of measurement, effect of different light source spectral content on fluorescent dyestuff or FWA and sensor differences.

At present day, following geometries are used during in-line measurement: $0^\circ:0^\circ$ and $45^\circ:0^\circ$ or $0^\circ:45^\circ$ either directional ($45^\circ:x:0^\circ$ or $0^\circ:45^\circ:x$) or circumferential ($45^\circ:a:0^\circ$ or $0^\circ:45^\circ:a$). One of known exceptions is X-Rite VeriColor Spectro with $30^\circ:x:0^\circ$ measuring geometry and ERX130 with $0^\circ:0^\circ$ geometry on the $22.5^\circ$ angle to the product.$^{1,2}$ How many measuring geometries are used in the production lab? The answer is typically two, but in fact more. Because diffuse measuring geometries are used in two modes: specular component included (di:$8^\circ$) and specular excluded (de:$8^\circ$), as an addition in pulp and paper industry, special diffuse measuring geometry d:$0^\circ$, which is specular excluded. Of course directional geometries are also used.

It is necessary to understand that treatment of non-diffuse reflection is different for each measuring geometry. Consider that high gloss is not captured by the receptor of directional geometries ($45^\circ:0^\circ$ or $0^\circ:45^\circ$), only diffusely reflected light. When compared with measurements made by a di:$8^\circ$ measuring geometry of lab instrument, the readings will be different. In the same fashion, color difference measurements between the standard and the product could be different depending on the gloss difference between the product and the standard. For example, color appearance of glossy samples will appear duller on di:$8^\circ$device in comparison to a device equipped with $45^\circ:a:0^\circ$ viewing geometry.

**Materials and methods**

VÚTS has developed a new color sensor for the on-line textile quality control system, which tries to solve all the above-mentioned problems. The simplified optical scheme of this new concept can be seen in Figure 1. Contrary to off-line measurement, where a sample in close contact with the measuring aperture is measured, here a controlled gap between integrating sphere and fabric loop is used. This dual beam spectrophotometer measures the reflectance value of each color at every 10 nanometers across the visible spectrum, 31 points of information to define the color. The VUTS in-line spectrophotometer eliminates the need for “correction algorithm for ambient light”, or “look up tables” for L*$a*b*$ data, or “special calibration for Status T” which are needed by camera solutions, or by long distance measuring systems. The whole prototype of VUTS measuring system has been tested for more than one year in Textile Company Nova Mosilana member of MARZOTTO Group.
**Results and discussion**

In-line measurement, in contrary to off-line measurements, is designed for measurement of moving fabric. It is simple to understand that the speed of movement can vary due to time and position of fabric on to measuring head. Based on that, sensitivity of colorimetric data on speed variability of measured fabric was tested. In the graph in Figure 3 it is visible that the measured data are more sensitive on short frequencies in speed variability in comparison to high difference of speed on the start of measurement.

This effect confirms to backing problem, as was mentioned before. That means that speed variability will cause a difference in fabric tension and consequently a difference in opacity. It is possible to solve such problem by FFT filtering of measured data based on known frequency, speed variability from speed sensor of measuring device.

As the output of the measurement, color maps are used which are the result of measurement on different position of fabric loop (Figure 4).
Conclusion

This paper describes the features of this color sensor and factors influencing measured colorimetric data. VÚTS has developed a new color sensor for the in-line textile quality control system and presented results confirm usability of this unique device.

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References