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Authentication of a Gravure Printer from Color Values using an Artificial Neural Network

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***Abstract*— Counterfeited packaging products (Pharmaceuticals) can create severe health hazard. While counterfeiting the pharmaceutical product, printing and packaging takes very crucial role as the customer buy the product by the attraction and information provided by the package. So the counterfeiters emphasize more on packages and associated printing. This work is focused on pharmaceutical package printing not only for its social implication but also for its technological variation. Since most of the medicines are packed in metal foil, the printing technology associated is gravure printing. Little work has been done on this technology and its security aspects. The common ways to counterfeit the packages are to copy the text and images of the package and to reproduce it. However, the variation of color while reprinting it may be assessed to check whether the printing is done by the original manufacturer or their authenticated printer house. Scanning or taking photographs of the package and re-printing is one of the methods to counterfeit the original package sample. Different digital camera, mobile camera, scanner etc have been used to scanned the original sample and then to reprint it. When the image of the original print is taken through different mobiles, camera or scanners, the color values are not the same as the original print even if it is printed on the same printer. However, when the scanned samples are reprinted with different printers, the differences are much higher in comparison to the original print. In this study, blister foil has been taken as substrate and a reference color chart (IT8.7/3) printed with 4-color gravure printing machine. The reference image has been printed with three different gravure printers (P1, P2 ,P3). Then the images of print samples are taken by different input devices. The images are then printed in those three printers again. Study the difference in Lightness and color differences are analyzed to assess the difference of print and reprint samples among different gravure printing press. Artificial Neural Network (ANN) model is used to predict the CIELAB color values of a print sample printed from a printer. In this study, 70% of color patches (total 928) have been used to train the network, 15% of the data used as cross-validation and 15% of the data is used to verify the accuracy of the network. Then the predicted color values of one printer are compared with other print and scanned reprint sample to assess the differences. It has been observed that the difference of predicted color values with the print samples are much less. The difference becomes much higher for scanned reprint samples. Hence it will be possible to identify the fake sample (if someone tries to reprint it after scanning or taking images of original multicolor artwork and reprints it). Hence the predicted difference could be used to protect medicine packaging from counterfeiting.**

***Keywords*— Counterfeited Print; L*a*b* values; ANN model; color difference; gravure printer*.

I. Introduction

Authentication and protection of printed documents generate new series of challenging problems due to the increase of counterfeiters and development of internet. In order to check if a printed artwork is original or is a fake resulting from a scan and print attack, color features can be used. The use of a Color Management System (CMS) is required to perform tasks such as device calibration, device characterization, color correction and quality evaluation. Unfortunately, color management of non-conventional devices (such as rotogravure printers) and non-conventional materials (such as aluminum foils paper) is not an easy task. But it is a necessary task to preserve image quality of prints on reflective materials, and to check if a print is original or not. The aim of this study is to demonstrate that color differences which could be used to detect an original print (color calibrated) from a fake sample, even if a color calibration or a post-processing is applied to the scan document before reprint. It has been demonstrated that scan and print processes create color distortions due to several parameters related to the printing press and gravure printing cylinders (print & reprint cylinders) used. In this study, the IT 8.7/3 color chart has been used as reference image and printed with three different gravure printing machines (P1, P2,P3) on blister foils. The IT 8.7/3 color chart consists of 928 color patches defined by various combinations of C, M, Y, K color primaries. The color profile of the printed samples has computed from measurements done with the Gretegmacbeth Spectroscan device. After capturing the (original) printed samples with a digital camera and then after engraving new cylinders to produce reprint samples (R1, R2, R3) with the same gravure printing machines. The color profile of the reprint samples has also been computed from measurements done with the Gretegmacbeth Spectroscan device. Rather than measuring L*a*b* colorimetric values of each print sample to compute color differences, we propose to use an Artificial Neural Network (ANN) model to predict L*a*b values from CMYK values. The experiments have done, with a set of color samples of the IT 8.7/3 color chart, and demonstrated that the accuracy of the prediction is very good. We propose to use the predicted values to assess if color differences between print and reprint samples are significant and not. The experiments done demonstrated that color differences can be seen as a very promising tool to differentiate a print from a reprint.

In section 2 a literature review is done on related works, next in section 3 we present the solution proposed to differentiate a print from a reprint and we introduce the technical information related to this solution. In Section 4 we present experimental results and discuss the robustness and the efficiency of this solution. Lastly, in Section 5, we discuss the outcomes of the proposed work and draw some conclusions.

II. RELATED WORK

The present work is based on gravure printing on blister foil. To the best of our knowledge, very few works have been done in this area. The main issue with aluminum foil papers is that this material is very specular and for such material, conventional color calibration methods [1] do not perform well. Among these conventional color calibration methods, some have been developed for digital cameras, meanwhile others have been developed for input and output devices. Gong et.al [2] proposed a solution which is based on a forward and backward colorimetric characterization process which makes it invariant to lighting condition changes. In case the image acquisitions are performed under same lighting conditions then this solution is only based on colorimetric characterization of the digital camera. In other cases i.e. when the image acquisitions are performed under different lighting conditions (e.g. D65 and D50), then this solution is based on the forward and backward colorimetric characterization process (D65 → D50, and D50 → D65). Emmel and Hersch [3] have developed solution of color calibration for input devices (scanner or digital camera), display devices (monitor) and output devices (printer). This solution uses a multi-dimensional Look Up Table (LUT) to establish a correspondence between a set of measured input color values and a set of measured output values. The tetrahedron space defined by the set of output values can be interpolated to compute new input value corresponding to any output value. This solution was used to calibrate a CMYK printer from CIE-XYZ values. The accuracy of this solution depends strongly of the size of the dataset which makes calibration cumbersome. One way to solve this issue is to use a prediction model to reduce the number of samples to measure. The Neugebauer model was used as color prediction model as it is well designed for modeling printed halftone samples. The advantage of the model is that the calibration process requests measuring only a few physical parameters oppositely to some other methods. In this paper we propose to use a color prediction model to reduce the number of color samples to measure, but for an evaluation purpose, not for a color calibration purpose. Another difference is that our prediction model is related to an Artificial Neural Network model and not a linear interpolation model. Huang et. al [4] has taken attention to introduce the idea of improving the color calibration process by the use of a neural network model and it was used to better characterize the non-linear behaviors of input (scanner) and output (printer) devices.

Another issue with gravure printing on blister foils is that the color samples printed on foil papers are printed with a rotogravure printer. It is very difficult to colorimetrically calibrate such printing device as many parameters, such as ink viscosity or concentration may impact the quality of the print [5]. Furthermore, the quality of a print does not depend only of the color signature of the inks used but also of their spectral signature. Some papers proposed a solution to analyze and compare spectral signatures of print dots. P**.** Grill and N. Rush [6] used two techniques (the Principal Component Analysis (PCA) and the Segment Classification (SC)) to analyze spectral data and color values (chroma, brightness, hue). The Yule–Nielsen Spectral Neugebauer model [7] was used for binary printer characterization. J.A. Stephen Viggiano [8] evaluated reflectance spectra difference using a meta meric index. This index was defined in reference to the sensitivity of the human visual system to evaluate color differences; it has the advantage to be not dependent on the illuminant conditions. Imai et. al [9] have compared different metrics like ratio of spectra, root mean square error, and goodness of fit coefficient. This study shown that none of these metrics performs better than another and that their use is dependent on the application. In our study case, the problem of color calibration was a sub-issue as color comparisons of print samples were performed from samples printed and reprinted with same printer and same printing parameters.

The main purpose of our study is to address the problem of authentication of printed artworks on foil papers using a rotogravure printer (CMYK printing process).Meanwhile most of papers of the state of the art studying the quality of prints are based on ink jet printers, few studies have studied on the quality of gravure spot color reproduction. Nevertheless, we can cite [10] which studied the impact of printing parameters (printer and software parameters) and gravure production substrate on quality of prints. Pandey et. al [11] analyzed the print quality relatively to different types of non-porous substrates for gravure printing. They compared the density and dot gain values for Cyan, Magenta, Yellow and Black (CMYK) channels for three types of substrates (milky poly, polyester and BOPP). They reported that, for all these substrates, the density value of black color (K) was almost the same, meanwhile the density values for C,M,Y colors were higher for polyester and milky-poly substrates and almost the same for BOPP substrate, with the same trend for C,M,Y colors. All C, M, Y and K colors showed almost similar trend for all tint levels (10%-100%) with different dot gain values. They also showed that Y color had less dot gain value, while K color had maximum dot gain value, and that the print quality was different for different substrates. They also reported that gravure printing quality is influenced by various factors, such as substrate properties, ink chemistry, viscosity, doctor's blade angle, cylinder pressure, rheological behavior, solvent evaporation rate, drying printing speed, etc. To the best of our knowledge, no investigation is reported in the state of the art on print quality of gravure printing on (non-porous) blister foils and on color differences between print and reprint samples printed using a gravure printing machines.

In the documents counterfeiting domain several counterfeit detection methods have been proposed and

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surveyed. Hyeon Lee and Yeoun Lee [12] developed a detection method of counterfeited bills produced by a scanning and printing technology was proposed. A deep learning algorithm, based on a convolution neural network (CNN) model, was proposed to detect counterfeit bills. They used grey level co-occurrence matrix to extract printing noise features to identify the forgery devices used. The detection accuracy rate was analyzed using three different laser printers. Results demonstrate that this method can be used to discriminate original from counterfeit bills and also to identify the forgery devices used. Oppositely to most of the papers in the documents counterfeiting domain which do not deal with gravure printed documents, Mandal and Bandyopadhyay [14,15,16] proposed a kinetic model to analyze the performance of waterfastness [14] on printed blister foil with time. They have also studied on lightfastness [15] using spectral curves and colorimetric values for foil substrate printed by gravure printing machine and print stability of blister foil packaging has been discussed using ANN [16]. The objective of our paper is to propose a simple but efficient solution to detect if gravure printed document is an original print or a reprint. The proposed solution is based on the computation of color differences between measured and predicted color values for print and reprint samples.

III. EXPERIMENTAL MATERIAL AND METHODS

A. Artificial Neural Network (ANN) Modeling

In many domains Artificial Neural Network is used as a data analysis method to solve nonlinear problem. For example, it is used in the medical domains for diagnosis and treatment purposes.

In this work, a conventional ANN configuration (Fig1) based on a multilayer "feed-forward" architecture has used. It consists of one input layer, one hidden layer, and one output layer. A convergence criterion was used for the training step. It described a set of weights during the supervised training, as the network begins to find the values needed to produce the correct response within some margin of error.

The signal flow (f) from inputs $x_1,\dots,x_n$ are considered to be unidirectional and the corresponding neuron's output signal flow (O) is given by:

$$O = f\left(\sum_{j=1}^{n} w_j x_j \right) \quad (1)$$

where w_j is a weight vector.

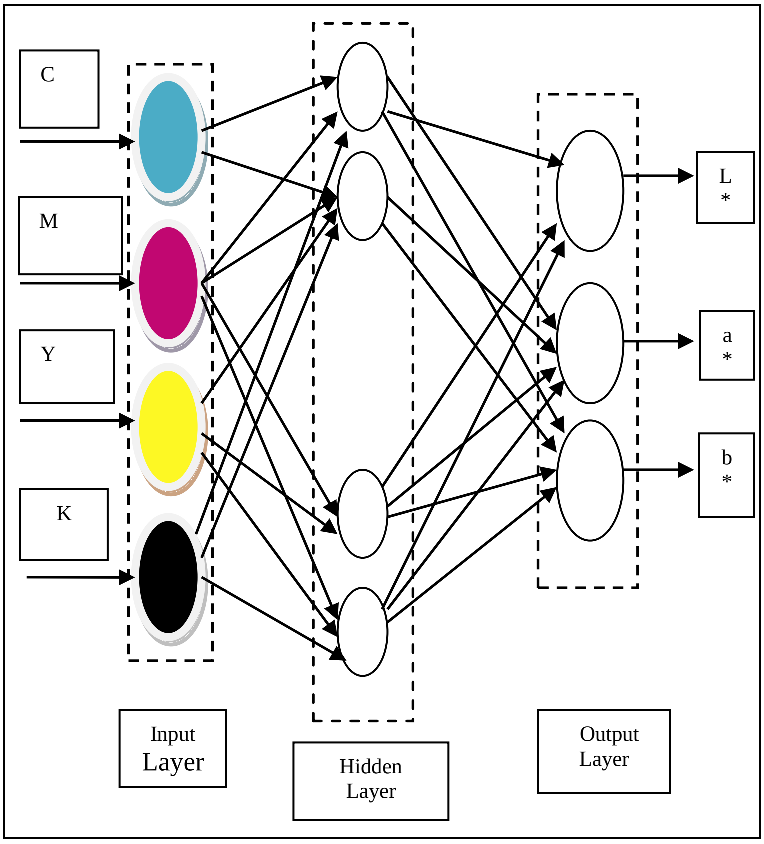

Fig.1: Artificial Neural Network Configuration

B. Color Difference

To assess if color differences between an original (print) and a tested sample (reprint) are visually noticeable, or not, for a human observer, we suggest to use the ΔE_{00} color difference formula [13]. We hypothesis that ΔE_{00}, color difference formula can also be used to quantify the color difference between print (original) and reprint (fake) samples.

C. Materials

- Substrate**:** To print the color chart blister foil has been used in this experiment. Blister foil has two different sides, one is matt side and another is glossy side. The same matt side of blister foils has been taken to print and reprint the color chart from different gravure printing machines for this experiment. The measured L*a*b* values of bare blister foil are L*:82.65, a*:0.51 and b*:3.63. L*a*b* values were set to same values to print the color chart with the three different printers.

- Ink**:** Same cyan(C),magenta(M),yellow(Y) and black(K) DIC inks has been used to print and reprint the color chart on blister foils for different gravure printing machines. In this study foil inks (DIC) have been used to print artwork from gravure machines. The following (TABLE I) standard viscosities of CMYK inks have maintained throughout the print-reprint process.

- Color chart**:** in this paper we limited our investigation to samples of the IT8.7/3 Color Chart resulting from a

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combination of three or more C, M, Y, K primaries. In the general case, the accuracy of the prediction of L*a*b* values from CMYK values is better for a single primary or for a combination of two primaries than with three or four primaries.

TABLE I: STANDARD VISCOSITY OF FOIL INKS (CMYK)

Description	Viscosity,Ford Cup 4 @30°	Unit of Measure
DK0020-AL GV, FOIL YELLOW	28 ± 5	Second
DK0020-AL GV, NEW FOIL MAGENTA	32 ± 5	Second
DK0020-GR,FOIL BLUE	27 ± 5	Second
DK0020-GR,FOIL BLACK	25 ± 5	Second

D. Procedure

In this study, the artwork IT8.7/3 Color Chart has been engraved as reference image on a gravure cylinder using an Electro-mechanical engraved process. Then, a first 4-color gravure printer (P1) has been used to print the engraved artwork on several blister foil substrates. Similarly, same cylinders have been used to print other samples using two other gravure printers (P2, P3).

The reference image has been printed on blister foils for a specific set of parameters such as surround temperature, humidity, heating, ink viscosity, gravure speed, angle of doctor's blade setting, cylinder making process, screen ruling, cylinder size. These parameters were set as follows: temperature: 31ºC, humidity: 75%, gravure speed: 17MPM, screen ruling: 150LPI, angle of doctor's blade: 30º, process: Electro-mechanical engraved, heating: 70ºC-80ºC, pressure of rubber roller: 2.5 kg/cm^2 (for each unit), pressure of doctor's blade: 1kg/cm^2 (for each unit), cylinder size: 325x500mm. The effects of these parameters on the results are out of the scopes of our study. In this study the same printing conditions have been kept for the print and reprint process, so that the changes reported are not due to changes of these parameters.

A digital camera (Sony alpha 350) has used to capture the printed color chart to duplicate (copy and paste) the original artwork. The images have taken in viewing booth with controlled illumination. Imatest Lightbox is used during calibration. Exposure is taken inside viewing booth. Camera calibration is done using basic color management procedure. In this paper, only Sony alpha 350 data is referred. Same temperature: 5800k, focal length: 3.5F, exposure time: 1, ISO:400 were used for all acquisitions for print-reprint process. The captured image is in RGB mode, so it has been converted into CMYK mode and separate the color channels for prepress process and has been engraved on another 4 cylinders (C,M,Y,K) gravure cylinder using an Electro-mechanical engraved process for reprint. The color chart images printed by the gravure printers (P1, P2, P3) were all captured under same illuminant conditions and reprint samples in same process.

A Gretagmacbeth Spectroscan device has been used to measure the CIE L*a*b* color values of the printed color chart, where L*(Lightness),a*(redness/greenness),and b* (yellowness/blueness) computed using the CIE D65 standard illuminant with a $0^0/45^0$ angle. We also measured the lightness of the different foil papers on which the color chart has printed and there has no significant difference of lightness. Thus, for foil 1 L* = 82.65, a* = 0.51 and b* = 3.63; for foil 2 L* = 82.45, a* = -0.68 and b* = 1.60; for foil 3 L* = 87.83, a*= -1.13 and b*=1.05.So, we can neglect the impact of the reflectance of the substrate on the measurements. These L* values of tested color patches have measured from different printed foil papers and the tested color patches mostly three-four color (CMYK) combinations. The IT8.7/3 color chart is defined by a set of 928 color patches, each of them having different c, m, y, k values. The color profile of each gravure printer has computed for each print and reprint from the color values of the printed and reprinted color chart measured with the Gretagmacbeth Spectroscan device.

We propose to use an Artificial Neural Network (ANN) model for predicting colorimetric values (L*a*b*) resulting from a mixture of color inks (cyan, magenta, yellow, black) printed on blister foil.

The framework of this network is illustrated in Fig2. The input (target) data of the network are the CMYK values of the color chart. The architecture of this ANN is based on 10 hidden neurons, 4 inputs, and 3 outputs, it has implemented in MATLAB. The w and b parameters in Figure 2 correspond to the weight and the bias of each layer. The w and b are represented as matrix of dimensionality (SxR) and (Sx1) respectively, where R is the number of elements in input vector and S is the number of neurons in layer. We tested this architecture to predict, next to validate, the colorimetric values of printed color patches. The output data of the network are the colorimetric values (L*a*b*) of the printed color chart on blister foil.

To train the network we used the Levenberg-Marquardt training algorithm ('trainlm' MATLAB function). The Levenberg-Marquardt method is an optimization method, based on back propagation, developed to solve data fitting problems using a mean squared normalized error performance function. One way to measure how well the neural network fits, the regression coefficient (R) has been computed for all samples. If the network learns to fit the data well, the linear fit to this output-target relationship should closely intersect the bottom-left and top-right corners of the regression plot (plot of input vs. output values) and the regression coefficient should be close to 1.If this is not the case then further training, or training a network with more hidden neurons, would be necessary.This network has first tested for the set of color samples printed with the first printer (P1, taken as reference). The R value is 0.988. This score confirms that the network can predict accurately the L*a*b* colorimetric values from the CMYK input values of the color chart. Similar R values have been obtained for the two other printers and for print and reprint samples. In all cases the network has able to predict accurately the L*a*b* colorimetric values from the CMYK input values of the used color chart.

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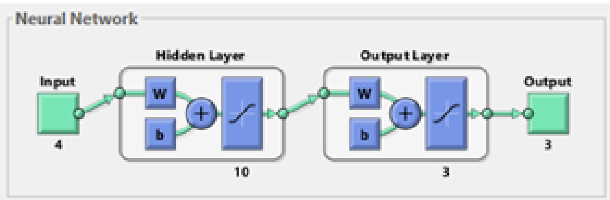

Fig2: Architecture of the ANN implemented in MATLAB

Next, the predicted L*a*b* values (computed from the reference printer P1) have compared with the measured L*a*b* values of two other printers (P2, P3) and also with the measured L*a*b* of reprint samples. From these comparisons we draw the hypothesis that the predicted L*a*b* values can be used as a tool to identify an original (print) sample from a fake (reprint) sample. These comparisons are based on color difference (ΔE_{ab}), chroma difference (ΔC_{ab}), hue difference (ΔH_{ab}), and lightness difference (ΔL), between two print color charts (e.g. P1 vs. P2) or between a print and a reprint (e.g. P1 vs. R1, as illustration see Fig3).

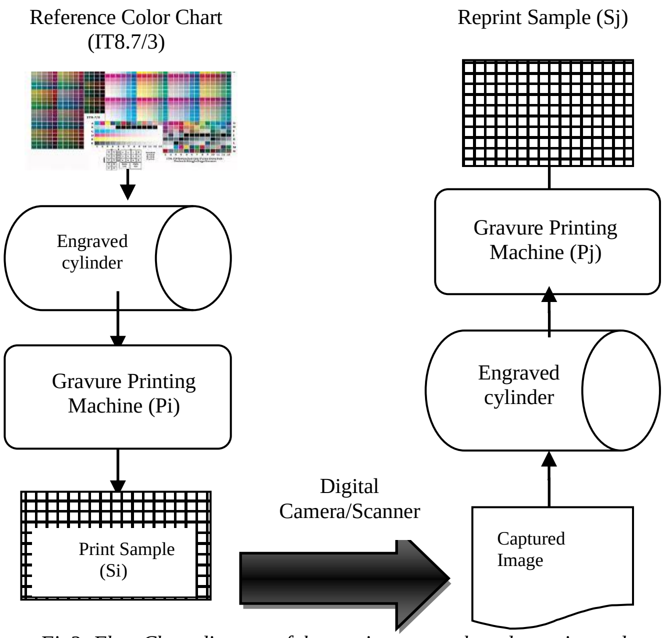

Fig3: Flow Chart diagram of the reprint process based on print-and-scan.

IV. RESULTS

To analyze the effect of the print process and of the reprint process on color values, and to analyze the effect of different printers and gravure cylinders (print & reprint), we perform the following comparisons. For these comparisons only few CMYK color print and reprint samples have been used.

a) Comparison of Predicted value L* (for reference printer P1) and Measured values L* for color patches printed by printers P1, P2 and P3. Plots shown in Fig4 correspond to print samples, meanwhile Fig5 corresponds to reprint samples.

Fig4 shows that the measured L* values of print samples are closer to predicted L* values when samples are printed with same gravure printing machine (i.e. same printing cylinder). Same for reprint samples when samples are printed with same gravure printing machine but with different printing cylinder, that is the variations of L* values between predicted and measured samples are higher for reprint than for print samples (see Fig5 vs. Fig4).

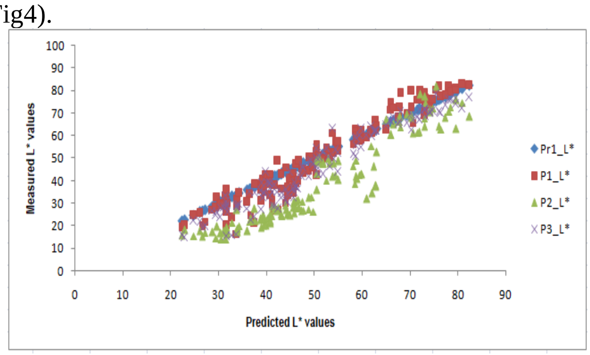

Fig4: Predicted (Pr1 for reference printer P1) vs. Measured L* values for print samples (for printers P1, P2 and P3)

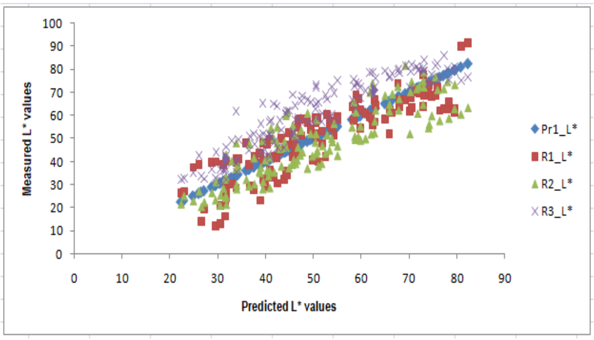

Fig5: Predicted (Pr1 for reference printer P1) vs. Measured L* values of reprint samples (for printers P1, P2 and P3)

b) Comparison of Predicted L* values (for reference printer P1) and Measured values L* of samples printed by printer Pi (P1, P2 or P3) and samples reprinted (R1, R2, R3) by same printer Pi(see Figures 6 to 8).

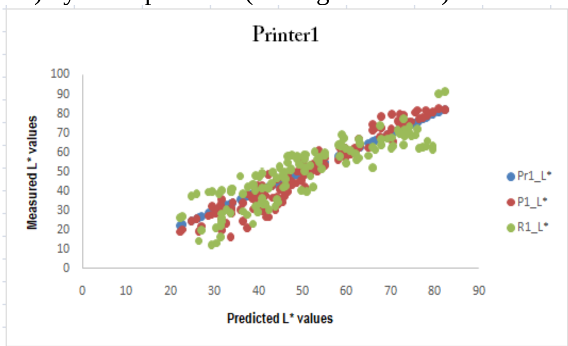

Fig 6: Predicted (Pr1 for reference printer P1) vs. Measured L* values (P1 for print and R1 for reprint samples) using Printer P1

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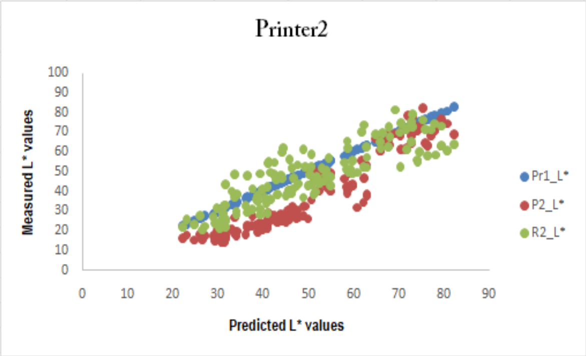

Fig7: Predicted (Pr1 for reference printer P1) vs. Measured L* values (P2 for print and R2 for reprint samples) using Printer P2

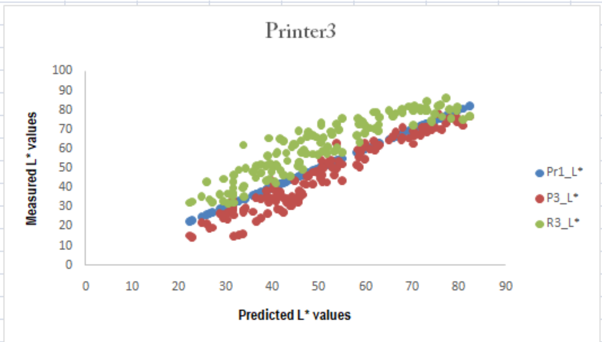

Fig 8: Predicted (Pr1 for reference printer P1) vs. Measured L* values (P3 for print and R3 reprint samples) using Printer P3

These L* values of tested color patches has been measured from different printed foil papers and the color patches mostly tested with three-four color (CMYK) combinations.

TABLE II: REGRESSION COEFFICIENT VALUES FOR PRINT AND REPRINT SAMPLES FOR THE THREE PRINTERS USED

Samples	Printer1	Printer2	Printer3
RCi(Print)	0.94	0.89	0.94
RCi(Reprint)	0.77	0.74	0.83

These L* values of tested color patches have measured from different printed foil papers. In the above graphs it has been observed that, for all printers (Pi, with i = 1, 2 or 3), the measured L* values of print samples (Pi_L*) are closer to the predicted L* values (Pri_L*) than the measured L* values of reprint samples (Ri_L*). Although the printing machines were identical for print and reprint, these differences are due to the different printing cylinders used. For each printer (Pi, with i = 1, 2 or 3), we plotted the regression graphs of Predicted vs. Measured L* values, next we compute the corresponding Regression Coefficients (RCi). For print samples, all RCi values are higher than 0.89 (see Table II). For reprint samples, all RCi values are lower. The all regression coefficients (RCi) for print and reprint samples are in TABLE II.

Another way to compare the measured L* values of print samples (Pi_L*) with the measured L* values of reprint samples (Ri_L*) is the use of bar plot, such as the one illustrated in Fig 9. This difference of L* values could be used as in indicator to identify an original from a fake. These differences are not due to a calibration problem as camera and print devices have already been calibrated before doing these experiments.

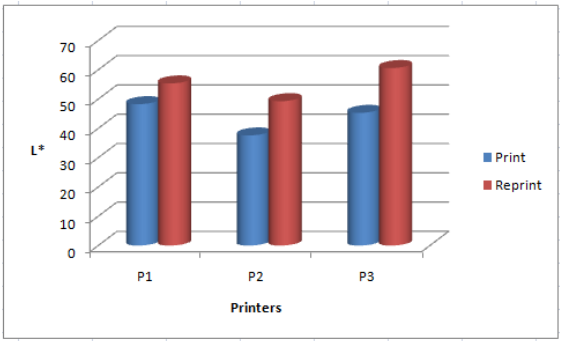

Fig 9: Measured L* values of print samples vs. measured L* values of reprint samples (for Printers P1, P2 and P3)

In the following Tables III and IV, lightness and color difference values between predicted L*a*b* and measured L*a*b* values, have computed from the 928 patches, 70% is used to train the network, 15% of the data used as cross-validation (15% of the data) is used to verify the accuracy of the network.

TABLE III: COMPARISON OF LIGHTNESS AND COLOR DIFFERENCES BETWEEN PREDICTED L*a*b* AND MEASURED L*a*b* VALUES FOR A SET OF PRINT SAMPLES (FOR PRINTERS P1, P2 AND P3)

Print Samples			
Parameters	*P1*	*P2*	*P3*
ΔL^*_{avg}	3.99	6.36	5.15
ΔE_{00}	5.41	7.76	5.81

TABLE IV: COMPARISON OF LIGHTNESS AND COLOR DIFFERENCES BETWEEN PREDICTED L*a*b* AND MEASURED L*a*b* VALUES FOR A SET OF REPRINT SAMPLES (FOR PRINTERS P1, P2 AND P3)

Reprint Samples			
Parameters	*R1*	*R2*	*R3*
ΔL^*_{avg}	11.35	8.22	10.91
ΔE_{00}	11.87	11.28	11.49

First for the prints (original prints, see Table III), next for the reprints (fake prints, see Table IV), lightness and color differences have been compared. It is important to remind that P1, P2 and P2 correspond to the three different printing machines used, meanwhile Pi and Ri correspond to the same printing machine (i = 1, 2 or 3) but different printing cylinders were used for print (on Pi) and reprint (on Ri). As lightness differences are significantly upper than chroma and hue differences, only lightness differences are reported in Tables III and IV.

From Tables III and Table IV, it can be observed that lightness and color average differences for all reprint samples are higher than for each print samples. For reprint samples, the color average difference is significantly higher than the print samples and in all cases upper than 10.0.So, we can hypothesis that a color average difference upper than 10.0 is characterized for a reprint (fake sample).

Fig10 and Fig11 show again that the color differences between predicted L*a*b* and measured L*a*b* values are in average higher for reprint samples than print samples for all three gravure printing machines. It has been confirmed that when an original print sample is copied (reprint) then the color average difference between predicted L*a*b* and measured L*a*b* values is not only high (upper than 10.0) but also significantly upper than the original print.

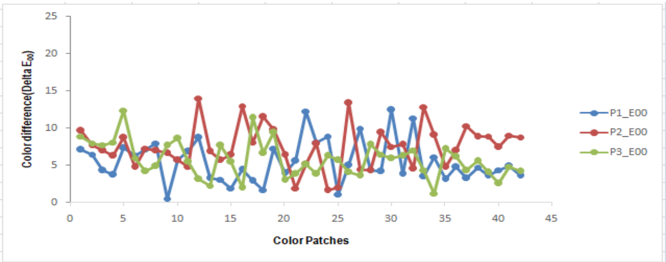

Fig10: Color average difference (ΔE_{00}), between predicted L*a*b* and measured L*a*b* values of print samples for each of the three gravure printers

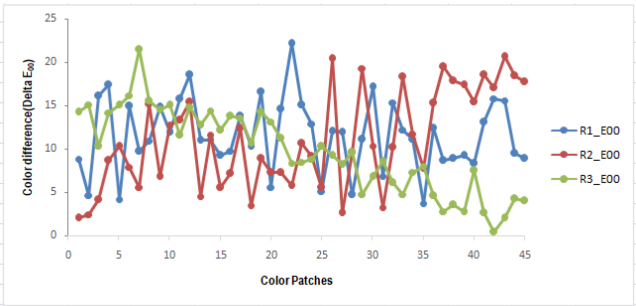

Fig11: Color difference (ΔE_{00}), between predicted L*a*b* and measured L*a*b* values of reprint samples for each of the three gravure printers

c) Comparison of contrast values of print samples for reference printer P1 with contrast values for printers P2 and P3, and contrast values of reprint samples printed with printers P1, P2 and P3.

The lightness contrast is defined as the ratio of maximum and minimum lightness values of predicted and measured L* values.

$$\text{Contrast} = \frac{L^*_{max(measured)} - L^*_{min(measured)}}{L^*_{max(predicted)} + L^*_{min(predicted)}}$$

The lightness contrast of the prints, with respect to predicted values for reference printer P1, is higher for the prints than for the reprints. The lightness contrast, computed from the predicted values, for the printer P1 is of 1.16. The lightness contrast for all three prints, computed from the measured values, is within the range 1.09 to 1.18. The lightness contrasts of the reprints, with respect to predicted values for reference printer P1, are within the range 0.84 to 0.90.

Colors samples were also compared by observers, they reported that the samples printed from an original artwork have better lightness contrast, higher saturation, and are much cleaner than reprint sample.

V. DISCUSSION & CONCLUSION

In this study, it has been shown that the colorimetric values of the IT 8.7/3 color chart printed on blister foils are different for different printers even if the same gravure cylinder has been used. An Artificial Neural Network (ANN) model has been used to predict the L*a*b* colorimetric values of color patches for a printer. For the predicted values of a print sample (printed with printer P1 taken as reference) has compared with measured values of three printers. The lightness difference and color differences of different printers are measured. It has shown that the color features can be seen as a very efficient tool to differentiate between print and reprint sample. It has been found that the lightness difference and color difference are much higher for scanned reprint samples with the predicted values in comparison to the original print samples. Hence the method can be used to identify whether a packaged print is printed by original manufacturers or their authorized printers or it is reprinted after scanning or taking image of the original artwork by the counterfeiters. For medicine packaging, the work has immense importance to identify counterfeited or fake medicines which has great social impact. From the study it may concluded that it is difficult for counterfeiters to counterfeit any multicolor artwork on blister foil through gravure printing process after scanning or capturing image of original (print) sample. In future work, the robustness of the method will be evaluated against small variations of printing parameters. The process may be extended to more image capture devices and for other printing processes like flexo or offset printing.

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