Print quality assessment for web offset colour printing machine in Newspaper production

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Abstract - Job and production processing steps in print production are highly automated, except print quality assessment. Forests-based technique is used for automatic print quality assessment in newspaper production based on independent values of several attributes based on print quality. Recent developments for assessing the print quality are image analysis and computer intelligence based techniques since manual analysis are time consuming and results are dependent on observer. The soft sensors are used to determine the values for attributes through data mining and image analysis (only colour). The experimental shows the better result for print quality evaluations. The total of 25 print quality attributes are measured automatically by testing the double grey bars on the newspaper and it can be used for expert system. Although mapping, random forest and clustering techniques have been used for investigating the print quality. Report shows that even min number of attributes can score max accuracy in prediction of print quality.

Keywords: Print quality, Print quality assessment, Random forest technique, double grey bar, web offset printing, Newspaper production.

I. INTRODUCTION

Offset printing is the most widely used commercial printing process in production of newspapers and magazines [1]. A multicolour image comprised of cyan, magenta, yellow and black dots of varying size usually called as halftone image. These halftone dots are then transferred to the printing plate through computer to plate process. Each colour takes up the separate plate for production. During production of newspaper various factors that affects the print quality are paper roughness, ink density, printing press, ink water balance, plate quality and processing and operator efficiency. Major deficiencies and problems occur only during printing; paper surface (wrinkle, smoothness, linting, motting and web breaks) and mis-registration of plates used for colour printing. Even though these problems are overcome still the quality of the print can be low since the assessment on print quality attributes are only through manual. Also values for print quality attributes are altered timely for instant requirement to improve the quality. Fig.1 shows the double grey bar which is printed on the edge of the newspaper used for visual and instrumental assessment of print quality attributes

II. RECENT PROGRESSES IN PRINT QUALITY ASSESSMENT

Recently image analysis and computer intelligence based techniques are used for assessing the print qualities since manual procedures are time consuming and results are dependent on observer. Developments in this area usually concern simulation of the most common print quality defects [3,4], inspection of one or several print quality attributes, such as the actual size and quality of printed dots [5], motting [6], CCD camera-based estimation of ink density [7], automatic detection and classification of various printing defects [8]. A recent study used Bayesian networks and genetic algorithms to model the overall print quality assessment by a group of people in electrophotography printing [9]. Guan et al. have recently developed a case based reasoning system for offset print quality control [10]. A variety of print quality cases are stored in a knowledge base and exploited for decision-making in the printing process. [2]. Perner developed a knowledge based image inspection system for automatic defect detection, classification, and misprint diagnosis in offset printing [8]. A CCD linear camera is used as an image sensor. The system can recognize defects, categorize them into one of 47 classes, including colour drift, and suggest actions for the operator to eliminate the cause of defect. Another image analysis based defect detection tool, assisting the press operator in
III. PRINT QUALITY ATTRIBUTES

The various print quality attributes are listed here are used in this work:

a. 1,2: Dot Formation (s_d, f_h)
b. 3,4: Dot gain (tonal value on black area of double grey bar & standard deviation)
c. 5-10: Mis- registration (cyan, magenta and yellow in both X and Y direction)
d. 11-14: Colour deviation (∆E of L*a*b*)
e. 15,16: Contrast (black and colour grey bar)
f. 17-20: Noise level (black, cyan, magenta and yellow ink in a grey bar)
g. 21: Ink deviation (from actual level)
h. 22-25: Ink density (black, cyan, magenta and yellow)

Altogether 25 parameters are used for assessing the quality of the print on double grey bar image. These attributes are evaluated by capturing the image on the digital image camera (CCD) for interpretation of values.

IV. SUBJECTIVE ASSESSMENT PROCEDURE

The experts (having knowledge of printing & quality) group of two and non-expert groups of five are teamed for evaluating print quality. For investigation MHI Diamond Spirit of sixcolour web offset printing machine is included for testing on the newspaper. This paper concentrates on two experiments overall quality of print and comparative analysis of various defective prints using 10 point scale, where 10 indicates highest quality or similarity between the prints. The first test uses the florescent lamp of colour temperature 3000 K [2] and second test was conducted in shop floor where printing was done with lamp colour temperature of 6500 K.

V. MONITORING THE PRINT QUALITY BY MACHINE

Temponi et al. suggested using grey balance, tone reproduction, and overall appearance as printing quality attributes [18]. To assess the overall printing quality level, the quality attributes are combined as a triangular fuzzy number [2]. In [19], it was suggested using fuzzy integration to aggregate print quality attributes, into an overall print quality measure. A system attempting to simulate human print quality assessment for simple prints made by laser and ink jet printers was presented in [20]. Using simple print features characterizing noise level, edge sharpness, and tonal contrast the system was trained to categorize prints into the "bad quality" and "good quality" classes. Both linear and nonlinear models were used to predict a print quality score by machine using print quality attributes as independent variables in this work. Random forest (RF) [21] was the main nonlinear modelling technique applied. Random forests have been successfully applied in a variety of fields and have several appealing properties. Due to low computational complexity, RF can handle thousands of variables of different types with many missing values [2].

A. Random Forest (RF)

Random forest, a general data mining tool proposed by Breiman [21], is a committee of weak learners—decision trees, i.e. CART [22]. A weak learner can be created using a training set X. A weak learner is a predictor f(x,X) having low bias and high variance. By randomly sampling from the set X, a collection of weak learners f(x,X, θ_k) can be created, where f(x,X, θ_k) is the kth weak learner and θ_k is the random vector selecting data points for the kth weak learner [2]. When solving classification problems, RF prediction is the unweighted majority of class votes. As the number of trees in RF increases, the test set error rates converge to a limit, meaning that there is no overfitting in large RFs [21]. For accuracy low bias and low correlation are essential.
VI. INVESTIGATION PROCESS

A. Subjective assessment of print quality

Test samples of thirty printed on 45 GSM News print Paper (gloss) coated grade with long grain of size 505 x 735 mm. The print quality was evaluated for registration defects, ink deviation, noise due to ink water unbalance and it’s indicated in the Fig.2 and related standard deviation indicated in Fig.3.

B. Print quality attributes measurement by machine

Attributes related to print quality were measured on the double grey bar printed on the end of the newsprint paper. Fig.1 represents the example of double grey bar which is measured on X and Y position of cyan, magenta and yellow parts of the bar with respect to the black. It is used to detect the mis-registration, colour deviation noise level, dot formation and dot again. Even though ink density can be estimated on grey bars using the technique suggested in [7], measurement of ink density by densitometer on a solid print area of the test newsprint prints, see Fig. 4. A data set is collected to implement the technique suggested in [7].

C. Evaluation of subjective print quality

Evaluation of subjective print quality required random forests, mapping and clustering technique. Based on the first experiment mapping was done to evaluate the subjective assessment score and the resultant data was further explore by random forests. The important task is to determine the most suitable print quality attributes for determining the principle directions of the mapped data. From the Fig.5 it is found that 3 mis-registration of magenta printing plate (X direction), 4 mis-registration of yellow printing plate (Y direction), 12 L*a*b component values and 4 contract values are assessed in the double grey bar image area considered as most important factors for assessment.

D. Predicting print quality score

By considering the most important factor from subjective evaluation random forests tree was created and selective variables are sliced according to the 25 print quality attributes. Average values of the subjective evaluations were used as the source data for designing the model. The three models simulated average subject, average expert, and average non-expert. First, the three models were designed using all 25 quality attributes as input variables as mention in the [2]. Also it was found that high score of print quality was obtained only when using four attributes 7, 10, 13, and 16 it is shown in the Fig.6. The average non-expert model provides more accuracy than average subject for the attributes 7, 10, 13 and 16. Also it is easy to
distinguish two maps either by lower or higher than average value of print quality. Linear regression model with d = 1, 2, 3 was created using all 23 attributes for comparing the random forests score. 

Fig.6. Print quality attributes for average subject model

E. Print quality comparisons for pair wise

Pair wise comparison was done for second experiment using 30 print samples for evaluating the most important variables like mis-registration and lab values. Clustering analysis were carried out for the above two variables since it occupies the major area of the print in the print sample it is showed in the Fig.7. Finally the Lab component has the high score and having negative impact in the test result.

Fig.7. Test sample for measuring print quality attributes

VII. CONCLUSION AND FUTURE WORK

The effectiveness of the automatic print quality assessing system depends on how well the result correlates with human judgements. An automatic print quality assessment system used in this work for measuring on the double grey bar image that can also be used in expert support system in paper making and printing industries. Even though there is a disagreement between subjective assessments and prediction from designed model are slightly encouraging. The effectiveness of the system can be determined only when we use limited number of attributes for assessment because of large variety of papers, inks and control parameter. Also there is a symptom of accuracy when experts assessing the print quality than non-expert, for mis-registration and colour deviation. The choice of the user; alternative equipment and materials are the factors for affecting the product quality.

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REFERENCE


