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A MECHATRONIC SYSTEM FOR COLOR REGISTRATION IN SHEET-FED OFFSET PRINTING

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ABSTRACT

In modern industries, it is important to monitor the output process by a suitable and low cost method. However, the vision-based techniques are the most powerful methods to collect different types of feedback depending on the used image processing algorithm. This paper describes a low cost mechatronic system for color to color registration in sheet-fed offset printing based on color image analysis. The proposed system consists of hardware construction and software algorithm with commonly available techniques. A complementary metal oxide semiconductors (CMOS) sensor is used to capture the image which is processed via the image processing software. The closed loop system control is based on the decision taken by the image analysis algorithm. The proposed mechatronic system succeeded to decrease detecting and correcting time of miss registration compared with the manual process.

KEY WORDS

Mechatronics, image processing, printing quality control.

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INTRODUCTION

In multicolor sheet fed press machines, the exact superimposition of overprinting different color separations for cyan, magenta, yellow, and black (color register) as shown in fig. 1. it is essential for quality multicolor printing. The operator must check the color registration marks with an accuracy of approximately 1/100 mm in circumferential and lateral direction.

In order to check the printed sheet while the printing process is running, the operator must drag a sheet from the delivery pile and inspect the printing defects to take the action required to correct these defects.

This often leads to considerable amount of wasted time, materials and compromising product quality. To automate the previous process to enhance the printing quality and save time, a proposed mechatronic system is introduced. The computer in the measurement and control system determines the deviations between the measured values and the set point values and calculates the adjustments that need to be made.

Standard imaging components like charge-coupled devices (CCD) cameras and frame grabbers (image digitizers) often transfer color image information using the RGB-color system (Red– Green–Blue). However, the RGB standard does not correlate with the human color perception. (Hue-saturation-intensity) HSI-system is more suitable model for interpretation of color images. This system is a close approximation of the behavior of the human color recognition [2,3].

It is based on the attributes Hue, Saturation, and Intensity, which are associated with the parameters of human color interpretation. Hue refers to the main wavelength of the color. Saturation depicts the amount of whiteness in the color. A red and a pink object may have the same hue but the pink object will have a lower saturation value owing to a larger amount of whiteness. The third attribute, intensity, is the quantity of total brightness. It is the gray scale version of a color which keeps the spatial information [4]. The HSI color space can be described as shown in Fig.2. Hue can be explained on a circular scale progressing from red to green to blue and back to red. Saturation is the length of the color vector relative to the radius of the circle and intensity is the amount of light.

Another benefit of HSI system is that the computational requirements needed to process an image will in many cases be one third of the requirements for doing the same operation with a RGB image. For instance, a green leaf can be turned into blue by simply changing the hue values for all its pixels. The image contrast can be improved by a high pass filtration of the intensity. Color comparison is a direct matching of respective hue and saturation value. Doing these operations in the RGB color space, it requires altering all the three parameters(R,G and B) and usually performing additional calculations.

THE PROPOSED MECHATRONIC COLOR REGISTERATION SYSTEM

The block diagram of the proposed system to automate the color registration process is shown in fig.3. The system consists of a CMOS sensor, a computer and DC motors.

The most commonly used sensors for digital image capturing are CCD or CMOS. The later offers more flexible addressing modes, readout capabilities, lower power consumption and lower production cost [5].

A one megapixel CMOS sensor is used to capture the register mark image, this image is fed to the computer with Intel core2due processor working at 2.20 GHz with 2 GB RAM, which handles the video stream, process and analyze the colors position deviation. The decisions are taken and send the correction commands to a microcontroller board which operates the motor to compensate the deviation in the next print Fig.4.

EXPERIMENTAL PROCEDURE

A video input object represents the connection between software and a video acquisition device at a high level. The toolbox automatically creates one source object associated with the video input object. The video source object represents a collection of one or more physical data sources that are treated as a single entity. The video format of the video stream is specified when creating the video input object as the third argument to the video input function to be YUY2 with resolution 640 pixels width and 480 pixels height to obtain a maximum resolution.

The ROI (region of interest) is configured to be 100 pixels width and 100 pixels height in order to reduce the amount of data processed while the compilation is going through the program to insure a better performance. The returned color space is converted to RGB color space to improve the red and blue color segmentation. Finally the frame grabber is sit to 5.

The software algorism immediately return a single image frame from the video object Fig. 5.a and starts to process it for the color segmentation, which is carried out by a sequence of operation to enhance the frame quality by noise filtration, smoothing and threshold processing.

The segmentation is carried out by converting the color frame to a gray image shown in fig.5.c and subtracts it from the red component of the color image fig. 5.b, by subtracting each element in array fig. 5.c, from the corresponding element in array fig. 5.b, and returns the difference in the corresponding element of the output array fig. 5.d, leads to the resulting image fig. 5.d with the highlighted areas for the more reds color in the image and dark areas for the less reds in the image.

The resulting image of fig.5.d is then subjected to a 2D median filtering to reduce "salt and pepper" noise as shown in fig. 6.b.

After median filtering, the image is compared to suitable threshold value to get a binary image; the output image fig. 7.b replaces all pixels in the input image with luminance greater than a level of 0.08 with the value 1 (white) and replaces all other pixels with the value 0 (black).

While the algorism is running, the noise of the captured frame may be generated by the nonlinearity of the ambient lighting conditions. This affect the accuracy of the image analyzing process it is important to perform a morphologically open binary image to remove small objects (isolated islands) as shown in fig.8 by removing all connected components (objects) that have fewer than 50 pixels from the binary image, producing another binary image with the unwanted segmentation removed.

It is necessary to label connected components in 2-D binary image in order to be ready for the property classification (bounding Box, Centroid, and Area). All the previous steps are carried out simultaneously for both the red and blue color. These steps are Ends by detecting the regions of each color and the centroid of the largest region as shown in fig. 9.

The difference in position between the two colors Centroids is easily calculated. According to the difference value, a command is sent via serial port ordering the microcontroller board with 16F877a microcontroller [6] which is programmed to control the movement of the dc motor.

CONCLUSION

In this paper, we have described a proposed mechatronic system in terms of its hardware modules, as well as an image processing algorithm to scan the color images and locate registration mark from a printed sheet. The proposed system enhances the printing quality and saves time by automatically monitor, detect and correct misregistration in printing process. The algorithm for this detection process was developed using image Acquisition tool. The miss registration detection was implemented to use computer vision technology. In addition to being tested in a laboratory environment, a prototype of this system was constructed and deployed to a pen plotter mechanism, where its performance was evaluated under operating conditions, and it was found that the vision system was able to successfully monitor and detect miss registration.

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List of figures

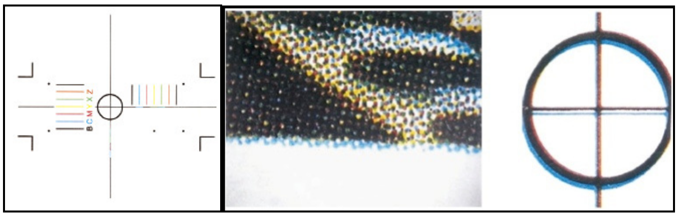

Fig. 1: Registration marks used to recognize the current position of each color [1].

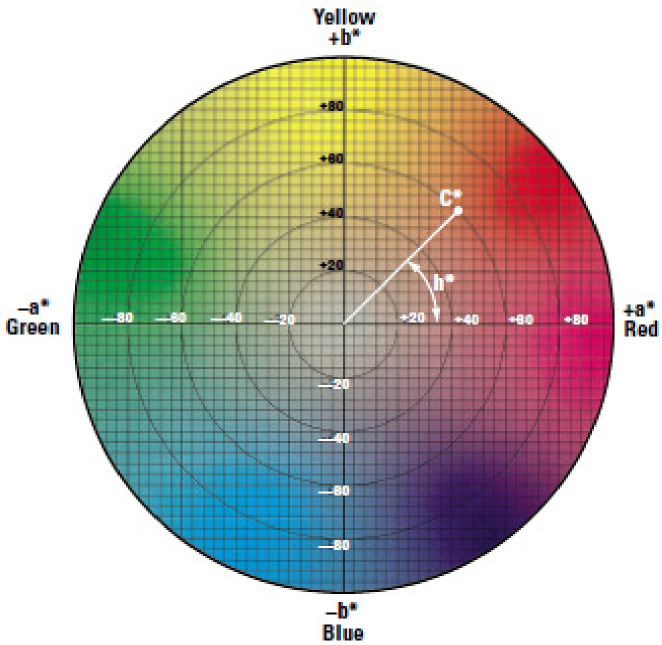

Fig. 2: The HSI coordinate system.

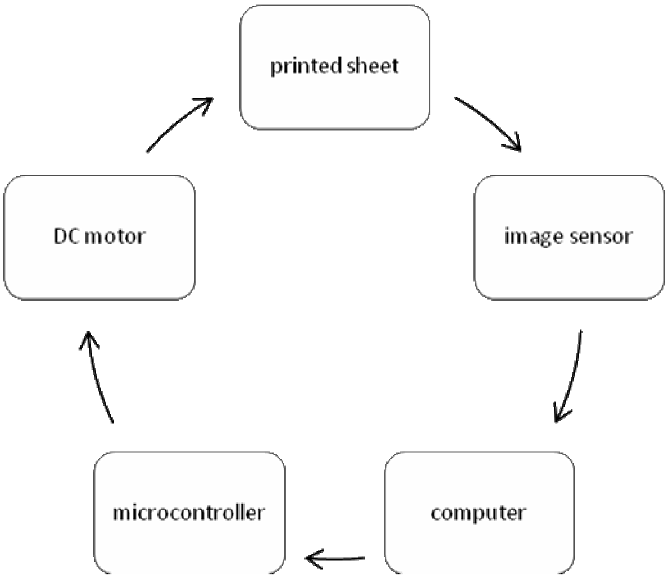

Fig. 3: Block diagram of the proposed mechatronic color registration system.

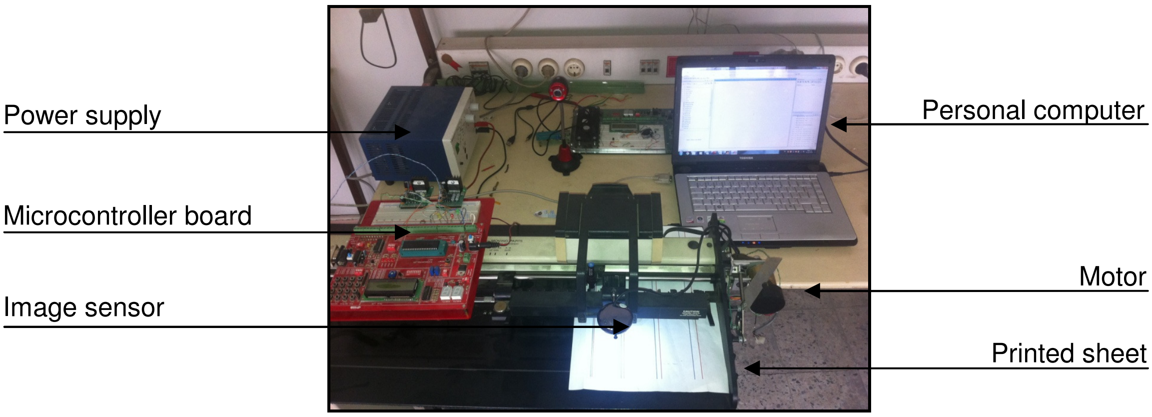

Fig. 4: The proposed mechatronic system setup.

Fig. 5: Red color extraction process; (a) Original image (b) Red component of the Original image (c) Gray image of the Original image (d) highlighted areas for the more reds color.

Fig. 6: Effect of 2D median filtering; (a) before (b) after.

Fig. 7: Image threshold; (a) before (b) after.

Fig. 8: Example of unwanted small objects.

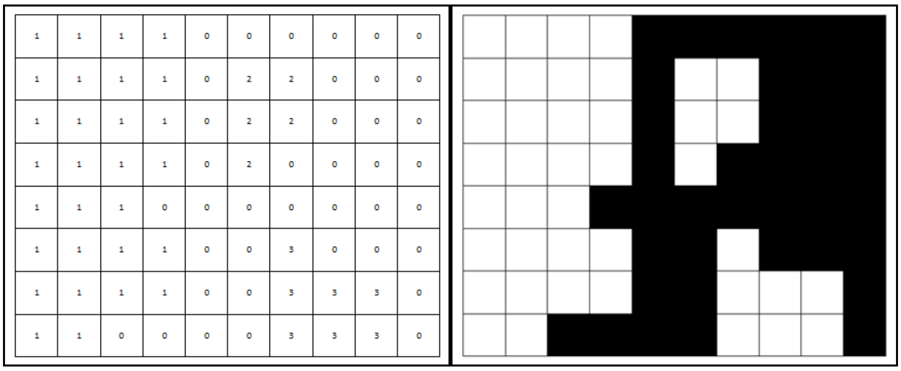

Fig. 9: Labeling connected regions.

Fig. 10: Examples of the resulting color segmentation frames.

Fig. 11: Position correction steps.