TECHNISCHE UNIVERSITÄT
ILMENAU

50. Internationales Wissenschaftliches Kolloquium

September, 19-23, 2005

Maschinenbau von Makro bis Nano / Mechanical Engineering from Macro to Nano

Proceedings

Fakultät für Maschinenbau /
Faculty of Mechanical Engineering

Impressum

Herausgeber:	Der Rektor der Technischen Universität Ilmenau Univ.-Prof. Dr. rer. nat. habil. Peter Scharff
Redaktion:	Referat Marketing und Studentische Angelegenheiten Andrea Schneider Fakultät für Maschinenbau Univ.-Prof. Dr.-Ing. habil. Peter Kurtz, Univ.-Prof. Dipl.-Ing. Dr. med. (habil.) Hartmut Witte, Univ.-Prof. Dr.-Ing. habil. Gerhard Linß, Dr.-Ing. Beate Schlütter, Dipl.-Biol. Danja Voges, Dipl.-Ing. Jörg Mämpel, Dipl.-Ing. Susanne Töpfer, Dipl.-Ing. Silke Stauche
Redaktionsschluss: (CD-Rom-Ausgabe)	31. August 2005
Technische Realisierung: (CD-Rom-Ausgabe)	Institut für Medientechnik an der TU Ilmenau Dipl.-Ing. Christian Weigel Dipl.-Ing. Helge Drumm Dipl.-Ing. Marco Albrecht
Technische Realisierung: (Online-Ausgabe)	Universitätsbibliothek Ilmenau ilmedia Postfach 10 05 65 98684 Ilmenau
Verlag:	isle Verlag ISLE, Betriebsstätte des ISLE e.V. Werner-von-Siemens-Str. 16 98693 Ilmenau

ISBN (Druckausgabe):	3-932633-98-9	(978-3-932633-98-0)
ISBN (CD-Rom-Ausgabe):	3-932633-99-7	(978-3-932633-99-7)

Startseite / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=15745

50. Internationales Wissenschaftliches Kolloquium
Technische Universität Ilmenau
19.-23. September 2005

H. Panaitopol / S. Petrache / D. Panaitopol

Researchs Regarding the Recognition of Banknotes Authenticity

ABSTRACT

A possibility to classify the valuable documents is represented by their colour. As far as the banknotes are concerned, one predominant colour is generally associated to a certain value. This fact represent one of the essential criteria for the automatic recognition of the authenticity of banknotes. The paper presents the author preoccupations regarding the design and the build of a laboratory platform for the acquisition and processing of the image. Finally, there are presented the research results concerning the recognition of banknotes authenticity using their colour.

SECURITY ELEMENTS USED FOR BANKNOTES PROTECTION

The ordinary counterfeits of the important currencies – which reproduce only the graphics of the original banknote - are replaced now by very good forgeries which reproduce also the security elements by using of a similar printing technology. All these facts impose the necessity of certifying the authentication by using of modern equipment to give the client and the bank the confidence that the transaction is done by using a genuine currency.

Elements detectable without special devices (for public use) are: - papers (special material of which the banknote are made); - printing, “intaglio” printing (cameo printing); cameo printing is used, in general, for the main drawing, portrait, emitter’s name value of the banknote (figures and letters) and signs for blind people; - the offset printing offer the possibility of realizing drawings of high fidelity, being used for the basic graphics (background) on the both sides of the banknote; - filigree; image (portrait, drawing, etc) done into the mass of paper by varying the density which is visible when viewed in light; - security thread (metallic or plastic); - iridescent coloured band (can not be reproduced by photocopying); - front and reverse

page superposition element (the drawings which one sees when looking at the two sides of the banknote in light must appear superposed); - latent image (element from the graphical composition which changes the image depending on the angle from which it is looked at); - optical sensible ink (element from the graphical composition which changes the colour depending on the angle from which it is looked at); - optical variable elements (holograms etc).

Elements detectable with special devices are: - anti-copying printing lines (very thin lines which cover homogenously and equally a part of the surface of the banknote and not reproducible with fidelity by photocopying); - microtext (high fidelity printing of a text with very small characters, smaller than 1 mm); - fluorescent elements on paper (fluorescent marks); - printing with luminescent/ fluorescent /magnetic ink; - dominant colour.

THE PLATFORM FOR IMAGE ACQUISITION

The platform (fig.1) for image acquisition used for this includes the following components: the lens 1; the CCD camera 2, specially designed for the acquisition board used in this project; acquisition board; the rack 3; light source 4; positioning table (carriage) 5. Beside these components an important part of project is the computer, which must be of high performance: PIV, 1,5GHz, 512 Mb RAM, 40 G hard disk.

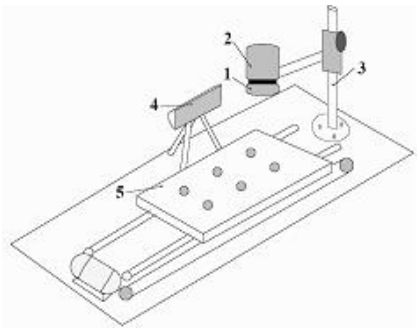

Fig. 1. The platform for image acquisition

THE DEVELOPED PROGRAMME

The application, presented in this paper, aims to extract the dominant shade of colour from a valuable document, for instance the banknote, the software being created on this purpose. The utilized programme was LabView 6.1 with the additional packet dedicated to the processing of the image IMAQ Vision. The program acquires the image of a banknote chosen by the user as

an etalon which, afterwards is memorized to be used as it is. This is used as etalon to make comparisons with the specter of the images of other banknotes of which authenticity is to be evaluated.

An other programme, in LabView as well is meant to control on the parallel port of the computer, of a small carriage which removes the banknote from an inactive zone of the platform in front of the lens of the camera's color head CCD and then it rebrings it in its initial position. The banknote is fixed on the plane side of the carriage by means of the vacuum.

The structure of the program implies two separated windows: one corresponding to the frontal pane representing the graphical interface with the user and a second one, in the background, which contains the diagrams used in the graphical programming used by LabView.

The user interface is presented in the fig. 2. This includes in the left upper part the name assigned to the interface from which the acquisition is done and the path to the file in which the intermediate image is wanted to be stored. These are defined by default but the user can change them as he needs. There are two main buttons for control: "Manner"– this establishes the way in which the acquisition is to be done: to store it as a pattern or to compare with an image which must be authenticated; "Acquisition"– this starts the acquisition process in a preset way. In the lower part of the frontal panel there are two graphs each of them indicating to the left, the extracted spectrum of colors in the case of the pattern or, to the right the current acquisition. These spectrums are obtained and displayed after the settings made by the user in function of the color sensitivity and the saturation level.

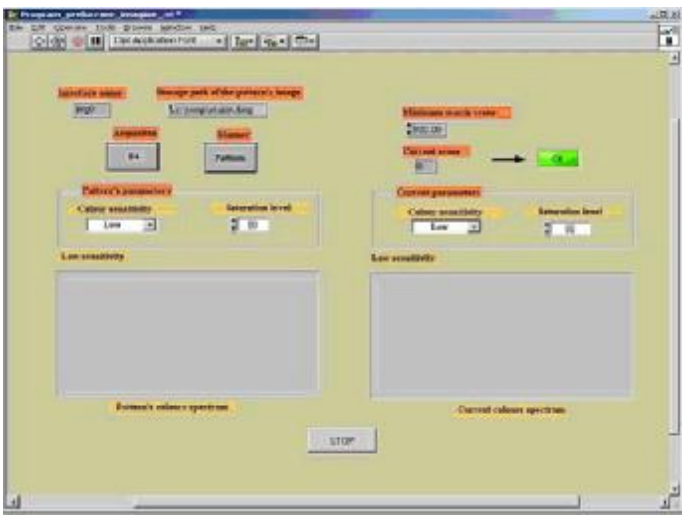

Fig. 2. The panel of the interface with the user

In general, it is indicated to use comparison for the low sensitivity spectrum. The high sensitivity spectrum is used when the images are very clear and the saturation level is kept at a value around 80, value which has been determined experimentally and which is also

recommended by the “help” of the program. Up at the right part, one can set the minimum value from which the image can be considered as containing an identical spectrum with the one of the standard image (the pattern). This value is set after some experiments at 930 from a maximum of 1000, but taking into account the conditions of the acquisition process (external factors such variable lighting or other disturbing factors) a new value is set after several comparison with the same image. It must be specified that even if the comparisons are made with the standard image, the results are not always 1000, but around 998, the value of 1000 being obtained only in few cases. Beside this interface window, a window pops up with the last saved image after each acquisition.

In order to describe and understand each stage of the process we shall use some diagrams.

In the first stage the hardware is initialized and a zone of memory is allocated for the acquisition process. This is the time when the properties and the type of image are set and a generic name is assigned to it, in this case the name being “image”.

Once this is done the program enter the sequence which includes the main cycle of the process. During this first cycle the motor is actuated through the parallel port for the advance movement of the rack. Once the image is captured (fig. 3), meaning it is stored in the memory, depending on the way the user wants to proceed, the process is continued by extracting the spectrum and storing it as a standard image (when it is used the “Pattern” mode (=False)) or the spectrum is extracted and compared with that of the stored spectrum of the standard image (when it is used the “Compare” mode (=True)). It must be mentioned that initially the state of the button is “Pattern” (=False) as it is in the logic of the program to consider that there is no standard image stored in the memory. When there is already an image stored in the memory the state of the button changes to “Compare”.

In the sequence corresponding to the mode “Pattern” for the Boolean state “False” there is a sequence of two states: - in the first sequence it is displayed the captured image and it is introduced a short delay; - in the second sequence, firstly the captured image is stored on the hard disk in bmp format and afterwards it is extracted and displayed its spectrum depending on the setting done by the user on the central panel (it depends on the sensitivity and the saturation level). The initial values are the minimum sensitivity and the value 80 for saturation. The set values for sensitivity can be “Low”, “Medium”, “High”, by this being set, in fact, the size of the matrix obtained as a result of the function” learning of the colors”; - by setting the sensitivity level, besides the action of modifying the matrix there is a sequence of displaying three graphs function of the size of the matrix.

When it is chosen the mode “Compare” firstly, the current captured image is displayed and afterwards it is done the comparison with the image stored on the hard disk. As in the case of mode “Pattern” firstly, the capture, made in a window with preset coordinates, is displayed on the screen and it is entered a delay of 500 ms.

After the image is displayed follows a sequence similar with that in the mode “Pastern” in which depending on the done settings, it is displayed the spectrum of low, medium or high sensitivities. The sequence of displaying the graphs representing the spectrum is similar with that presented above for the mode “Pattern” (low, medium and high).

After the image is captured and processed in one of the two modes “Pattern” or “Compare” the rack with the banknote is moved backward. For doing this there will be a command sequence of the motor similar with that for the forward movement.

In the following sequence the bite corresponding to the terminal sensor is read at intervals of 100 ms. When the rack gets at the end of the backward stroke the sensor will end the cycle and the bites will be reset in order to stop the motor. After a whole acquisition cycle is

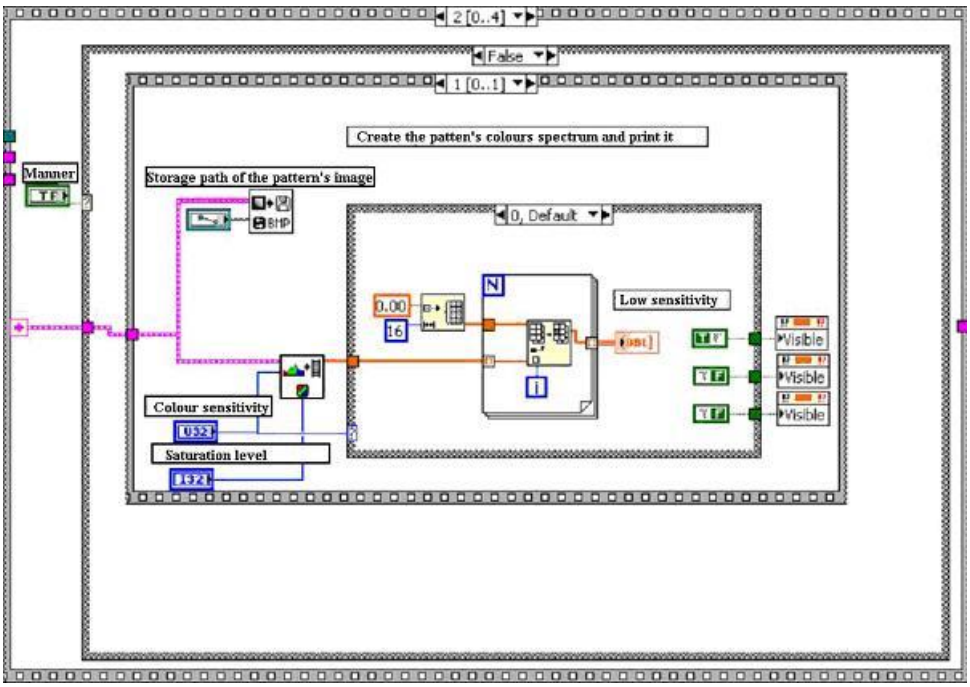

Fig. 3. The diagram for the capture of the image from the document

done, meaning the movement of the rack toward the head followed by the acquisition cycle and the retraction of the rack , the program enters a cycle of waiting for the user to do the new settings through the frontal panel in order to start a new acquisition and to change the bank-note. Thus, if the user wants to do another acquisition he has to push the button “Acquisition” from

the frontal panel or he has the option of giving up to a new cycle by pushing of the button "Stop".

If the user's option was to interrupt the program, this enters the final sequence during which the resources used by the application are free of and the window of the last acquisition is shut down.

With another module of the programme LabView, optic character recognition (OCR), the authors have succeeded in identifying the serial number of the banknote. The identification of the serial number can provide information on the banknotes circulating at a certain moment and, at the same time, it offers the possibility of obtaining some data which are eventually used in the banking system. The identification of the banknote can also be done by reading its value. The research is in work. Up to now there haven't obtained significant results because of the ambient light only. The contrast between the background an the written characters has to be stronger in this case.

CONCLUSION

The experiments made in the laboratory allowed the identification of an inadvertence between the spectrum of a current banknote obtained by the modification with 2 % of the surface of the standard banknote and the spectrum of the last one.

References:

[1] Burke, M., 1996, Image Acquisition, handbook of machine vision engineering vol. 1, Kluwer Academic Publishers, Dordrecht. Hardbound**;**
[2] Horner, J., 1994, Optical pattern recognition for anti-counterfeiting and security systems. Optical Processing & Computing, SPIE, vol.5, no.2. November, 1994, pp 6-7;
[3] Panaitopol, H., Petrache, S., Panaitopol, D., The Image Processing Utilized to Recognize the Authenticity of the Valuable Document, Poland, Machine Dynamics Problems 2004, vol.28. No.4, pp. 69-70;
[4] Relf, G., C., 2003, Image Acquisition and Processing with LabVIEW, CRC Press –National Instruments.

Authors:

Ph. D. Panaitopol Horia [1)]
Dipl. ing. Petrache Silviu [1)]
cand. ing. Panaitopol Dorin [2)]
[1)] Precision Mechanics and Mechatronics Dept.,
[2)] Electronics and Telecommunications Dept.,
Politehnica University of Bucharest,
Spl. Independentei 313, Sector 6, 060042 Bucharest, ROMANIA
Phone: +4021 402 92 15;
Fax: +4021 402 93 81;
E-mail: hpanait@me.mecatronica.pub.ro