

A Novel and Innovative Technique to Decipher Indented Writings by Means of Ferromagnetic Powder and Image Enhancement Tools

Dr. Kapil Kumar¹, Parvesh Sharma², Prof. Shobhana K. Menon^{3*}

^{1,2,3}Department of Forensic Science, School of Science, Gujarat University, Ahmedabad, Gujarat

Abstract: - An attempt is made to develop a new method other than based on electrostatic principle as used in Electrostatic detection Apparatus (ESDA) for deciphering indented writing in forensic investigations. Simulated indented samples were examined under various light sources and using image enhancement tools. The developed method is not effect by humidity variations as in ESDA. No need of cascade for development. The results are permanent and have scope for improvement. The results obviously show that this new technique can be used as an ad-hoc and alternative instrument for recovery and revealing indented writing impressions.

Key Words: Indented, ESDA, Magnetic powder, Image enhancement.

I. INTRODUCTION

In Forensic investigations many of the times it become important to decipher the indented writing contents i.e. whether two or more sheets of papers are stacked, traces of the writing executed on the top page tend to become indented on the sheets below. In cases of additions, anonymous Note/letters, alteration, Pages next to those torn out of a diary, address book can reveal what has been removed, order in which writings on different pages such examinations leads to new evidential proofs.^[1]

Many researchers published in this regard, like using radioactive 35-sulphur dioxide gas^[3], by means of replicas made with vinylite or other thermoplastics^[4], by Electrostatic Detection Apparatus (ESDA)^{[5] [6] [7]}, impression by traced forgery^[8], gelatin lifting^[9] and examining the effects of paper type, pen type, writing pressure and angle of intersection on white and dark dominance in ESDA impressions of sequenced strokes^[10]. Using a commercial scanner and image enhancement software as an alternative instrument for the recovery of the indented writing impression in paper, the numbers of underlying sheets negatively correlate with the revealed indented impression images made by flatbed scanners, but with limitations of types of paper being used^[11].

Electrostatic detection Apparatus (ESDA) is accepted as the most popular system for deciphering indented writings, the method has system for deciphering indented writings; the method has few limitations, like the requirement to maintain the moisture of the paper, the effect of thickness of the paper, depth of indentation and cascade quality apart from the cost of

the instrument. This motivated us to develop a system to decipher indented writing by using magnetic powder instead of Cascade powder for development of indented writing. However since samples developed by using magnetic powder may not give the require resolution, we proposed to improve the results with the help of image enhancement software^[12].

II. METHODOLOGY

2.1. Sample preparation

A total of 30 samples were created on various types of paper such as 80 g/m² A4 office paper and glossy paper in three categories i.e. Heavy writing pressure, Medium or normal writing pressure and Light writing pressure were prepared. A ball point pen was used to write the test words "INDENTED IMPRESSIONS FOR ESDA" on the top surface of the paper while three similar underlying sheets were used in the process of examination. The chosen phrase of words contains major strokes, such as horizontal lines, vertical lines and diagonal lines, which are normally & abundantly found in writing.

The recovery process for the indented writing was conducted firstly by using ESDA (as standard for comparison), using Magnetic powder & with Image Enhancement Software.

The ESDA- Lite manufactured by Foster and Freeman was used first to recover the writing impressions and its results were used as reference for comparison with the recovered impressions made by magnetism along with image enhancement software.

2.2. Procedure :

A magnet of power ranging between 1.5 to 2.0 tesla was used. Magnet employs a magnetic field. Every Magnet has its own magnetic field which is defined as magnetic lines in the elliptical shape. Polyethylene sheet is applied on the sample document to prevent the ferromagnetic powder from directly adhering to document, as it will violate document examination protocol. The sample document is placed on the vacuum box having very fine pores and ferromagnetic powder was applied on the surface of the polyethylene sheet which is kept above document. The model contain a rectangular box having fine pores on its upper surface and an opening is made on its side to attach a vacuum with the model (Figure: 3). When magnet

having high power (range 1.5 -2.0 tesla) is applied, some quantity of the ferromagnetic powder adheres on the indented surface. Hence the indented surface is now ostensible because of the ferromagnetic powder in the indented area and is secured by using adhesive transparent film subsequently photographed for recording purposes.

The sample prepared is put on the slab in the dark room. The sample is then photographed with high performance camera. Prior to photography, an oblique light is directed on the sample from different angles. The reason behind the placement of oblique light is that whenever light falls on the sample the indented surface makes a shadow of that indented surface or part of it and one can see the shadow of the indented surface. On photography this shadow of the indented surface and the indented surface itself is captured in the photograph. This digital image of the sample is then subjected to image enhancement software (**Adobe Photoshop CS6**) the image enhancement software should improve the clarity and contrast the image of the writing impression. There are different parameters or one can say options in the Adobe Photoshop CS6. For enhancement in Adobe Photoshop CS6, the parameters which were taken under consideration are Brightness, Contrast, Sharpness, Saturation, Hue, Lightness and Liquefy.

There is more than enough option in the image enhancement software to enhance the image we have tried to use the best of them but there may be a chance to further enhancement.

The assessment could be done by a direct comparison in terms of clarity and contrast between the ESDA result and result obtained the present method. "The paper quality" is designed to investigate the number of legible images obtained from the recovery of indented writing impression from interleaving glossy paper. "The variation of writing pressure" is designed to investigate the effect of the writing pressure on various types of paper for the recovery of indented writing impression.

The result evaluation was a qualitative measurement. The experimental results were reported as four levels: clearly readable, hardly readable, and visible (illegible) and not visible.

III. RESULTS AND DISCUSSION

In the present investigation ESDA was used first to recover the indented writing impression from underlying sheet, as a standard. The images obtained were then used as references for comparison with the corresponding results obtained from the magnetism and image enhancement software.

In this test, ESDA could recover the indented writing impressions from all the samples. Then the underlying sheets of samples were developed by the use of magnetism and imaging enhancement software (Adobe Photoshop CS6) using the image function.

3.1. Development of indented writing by using image enhancement

An average writing pressure obtained from thirty volunteers writing the statement "INDENTED IMPRESSIONS FOR ESDA" on paper. The developed writing samples obtained in three variations are as follows:

All three pressure levels were applied for writing on fifteen types of papers such as deposit slip, cash bill, lease agreement document and newspaper. All the samples were developed by means of magnetism and then photographed.

The image of the result obtained from the magnetism was adjusted by image enhancement software (Adobe Photoshop CS 6) using the image function and sharpen function. The use of image enhancement software reveals all the indented impression more in heavy and medium writing pressure and up to some extent in light writing pressure also.

The ESDA could not reveal the indented writing impressions from underlying sheets, the variation of writing pressure, the method of magnetism and image enhancement software could recover the heavy pressure indented writing on glossy sheet.

The newly developed method could recover the indented writing impression on most of selected samples. The numbers of underlying sheets that indented impression could be recovered for heavy, normal and weak writing force were descending respectively.

Out of the results obtained by the indented writing development using magnetism, it is concluded that magnetism can play a vital important tool for deciphering indented writing as it has more advantage and convenience compared to that of ESDA. Experiments indicate the possibility of using magnetism as one of a tool, in which a commercially available magnet, vacuum box and image enhancement software as an ad-hoc and alternative instrument for the recovery of the indented writing impression on paper.

The number of underlying sheets positively correlates with the revealed writing impression images. Types of paper have influence in revealing the images.

Paper that is thin, no glossy and no pattern are easier in finding the indented impressions. Writing pressure can also affect the legibility of the recovered impression.

Developing indented writing by magnetism is cost effective and less hazardous, as it do not contain electric charge where as in ESDA high static charge created by corona rod may be hazardous to the person developing the indented writing.

REFERENCES

- [1]. J. S. Kelly and B. S. Lindblom, Scientific Examination of Questioned Documents, Boca Raton London New York: CRC Taylor & Francis Group, 2006.
- [2]. D. Ellen, Scientific Examination of Documents Methods and Techniques, Boca Raton London New York: CRC Taylor & Francis Group, 2006.
- [3]. A. C. WELLS, "A Novel Method for Revealing Unintended Handwriting Impressions on underlying Layers of Paper," Journal of Forensic Science Society, vol. 16, pp. 201-203, 1977.

- [4]. A. Longhetti and P. L. Kirk, "RESTORATION AND DECI-PHERMENT OF ERASURES AND OBLITERATED OR IN-DENTED WRITING," Journal of Criminal Law and Criminology, vol. 41, no. 4, pp. 518-522, 1950-1951.
- [5]. L. WANXIANG and C. XIAOLING, "A study of the principle of the electrostatic imaging technique," Journal of the Forensic Society, vol. 28, pp. 237-242, 1988.
- [6]. S. J. Strach, G. M. McCormack, W. R. Radley and P. D. West-wood, "Secondary impressions of writing detected by ESDA," Forensic Science International, vol. 74, pp. 193-204, 1995.
- [7]. O. P. JASUJA and A. K. SINGLA, "PRESERVING ELECTRO-STATIC DETECTION APPARATUS (ESDA) IMAGES: A NEW APPROACH," Forensic Science International, vol. 52, pp. 21-23, 1991.
- [8]. R. D. Kullman, M. Sinke and E. Speckin, "Impression by Traced Forgery," Journal of the American Academy of Questioned Document Examiners, vol. 5, no. 1, pp. 1-11, 2001.
- [9]. J. A. d. Koeijer, C. E. Berger, W. Glas and H. T. Madhuizen, "Gelatine Lifting, a Novel Technique for the Examination of Indented Writing," Journal of Forensic Sciences, vol. 51, pp. 908-914, 2006.
- [10]. N. N. Daeid, L. Whitehead and M. Allen, "Examining the Effect of paper type, Pen Type, Writing pressure and angle of intersec-tion on white and dark dominance in ESDA impressions of se- quenced strokes- An application of the likelihood ratio," Forensic Science International, vol. 181, pp. 32-35, 2008.
- [11]. O. Saranchuen, R. Chitaree and T. Boonyarith, "FORENSIC EX-AMINATION OF INDENTED WRITING IMPRESSIONS IN QUESTIONED DOCUMENTS BY FLATBED SCANNERS," in 38th Congress on Science and Technology of Thailand , Thailand, 2012.
- [12]. D. M. ELLEN, D. J. FOSTER and D. J. MORANTZ, "THE USE OF ELECTROSTATIC IMAGING IN THE DETECTION OF INDENTED IMPRESSIONS," Forensic Science International , pp. 53-60, 1980.

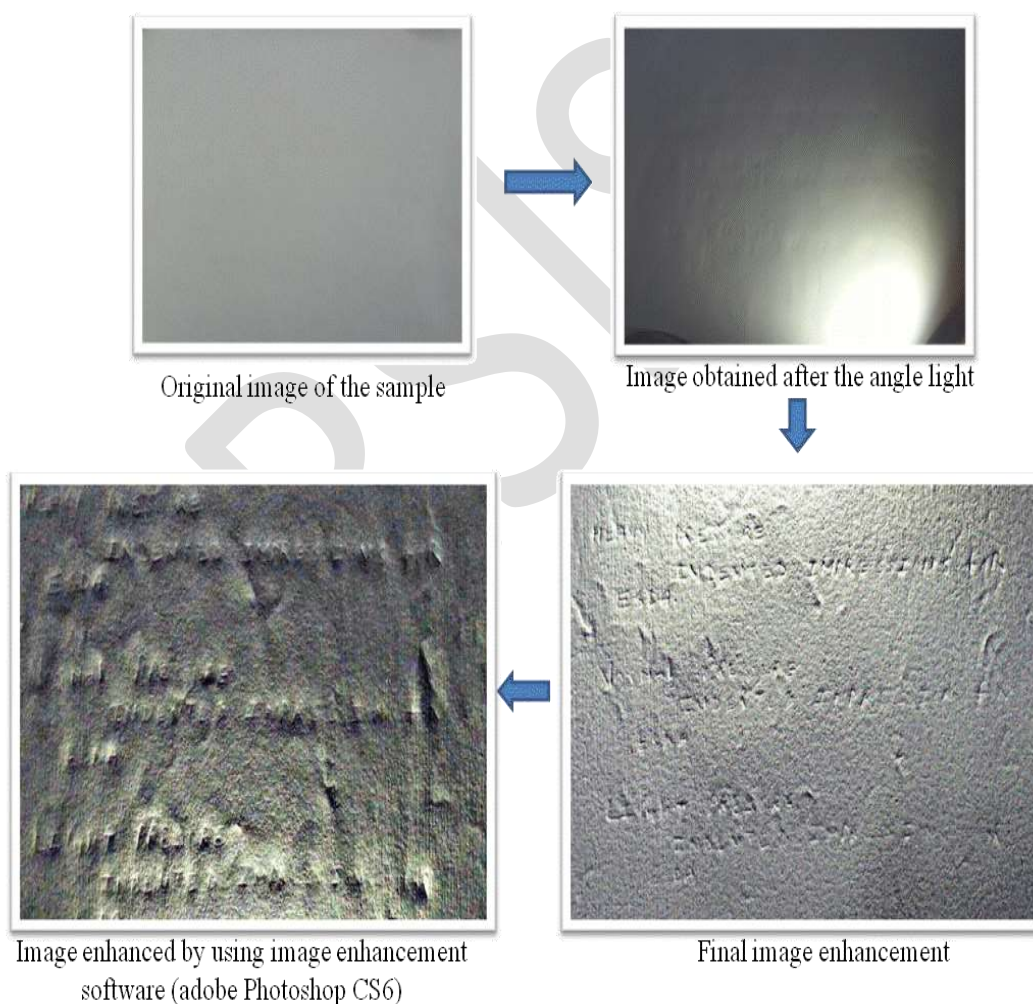


Figure-1

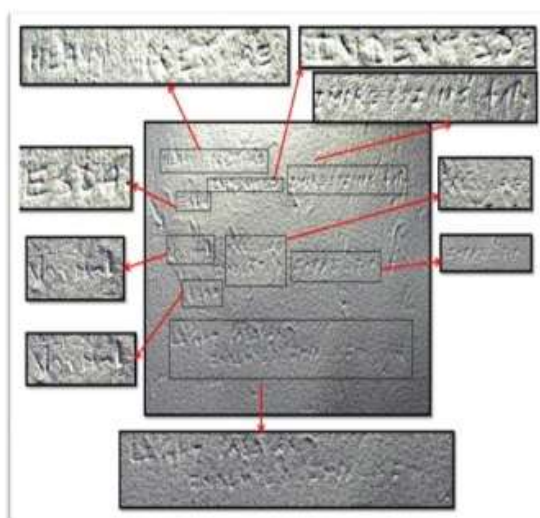


Figure-2

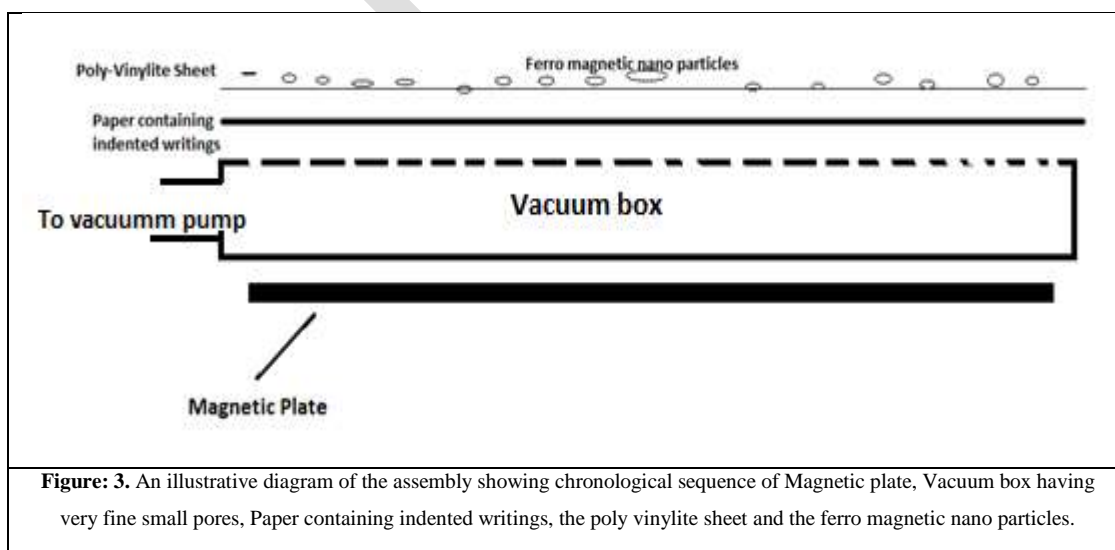


Figure: 3. An illustrative diagram of the assembly showing chronological sequence of Magnetic plate, Vacuum box having very fine small pores, Paper containing indented writings, the poly vinylite sheet and the ferro magnetic nano particles.