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Recovering Written Contents of a Burnt Paper by the IR Reflected Photography

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Papers are usually completed in writing ink from ballpoint pen, fountain pen, gel pen. When they are burnt, the contents written on the papers become charred and hard to be seen under the white light illumination. The method that is possible to recover the contents is to use the infrared reflected photography technique. In this research, a digital camera with a simple infrared light source is used to view the contents. The method is proved to be feasible and easy to implement for the forensic document examination.

Keywords: burnt paper, writing ink, infrared reflected photography

1. INTRODUCTION

Documents are made from many kinds of materials that have marks, signs, or symbols to send messages or make understanding to someone. Furthermore, documents play a crucial role in forensic caseworks because they start with a birth certificate and end with a dead certificate in human life[1]. Most documents are made from paper and completed in ink that were written by writing pen such as ballpoint pen, fountain pen, gel pen, etc. If these papers are burnt from fire, their contents will disappear and become charred. Charred document becomes blackened and brittle from being exposed to high heat without enough oxygen to burn[2]. Furthermore, paper tends to curl because the different expansion of burnt fibers on both sides of paper is different[3]. To collect such a breakable object; the investigator must have elaborate methods to take it from the scene to the laboratory of the document examination. This painstaking process may be avoided, if the investigator has an easy way to collect all contents from the burnt document with easier methods and off-the-shelve equipment.

Forensic Document Examination is a field in forensic science whose majority routine work is to examine the questioned document. This work needs highly skilled personnel with special trainings and access to suitable equipment in laboratories[4]. This is evident that many instruments and methods for the examination of charred documents, obliterated documents and erased documents are continuously developed. Generally, the first method to examine document is photography with visible light. Photography is the first step of crime scene investigation upon arrival at the scene. The evidence photography is indispensable for evaluation, interpretation and presentation of the physical evidence. The method is also considered to be non-destructive and non-contact for the evidence collection because the crime scene is absolutely not tampered and disturbed. There are four basic views of scene photography: overall views, medium views, close-up views and specific evidence views - these photographs selectively record an item of evidence or something peculiar to that items. Photography with the infrared radiation is also possible. This method exploits the different reflectivity between the written contents and paper background. This can produce a clear contrast when being viewed by an IR digital camera[5].

2. MATERIALS AND METHODS

2.1 Preparation of Samples

There are two types of paper used in this study: cash bill (basis weight 55 grams) and white plain paper (basis weight 80 grams). The size of each paper was 5×10 cm^2. The messages "BURNT" with three different sizes: 1.0 cm, 1.5 cm, 2.0 cm were written by three different pens: a ballpoint pen, a fountain pen and a gel pen. One sheet of paper contained three written messages in three sizes. Paper samples were burnt in a muffle furnace at a temperature within a range of 250 °C - 400 °C for 10 minutes. Different temperature values between the chosen range were set as burning temperatures such as 350°C and 380°C.

2.2 Optical Technique

IR LEDs were used as a light source. The wavelength of the emitted light is about 957 nm. The digital compact camera was modified to respond to IR by removing infrared cut-off filter. The setup diagram for reflected photography can be seen from Fig.1. The range of the incident angle is chosen to be 15°-75° with 15° stepping. This factor needs to be optimized because, theoretically, the reflectivity of surfaces is a function of the incident angles. In addition, different surfaces always posses different values of reflectivity. Therefore, the most suitable angle in the study is expected to provide a good contrast between the written contents and the paper background.

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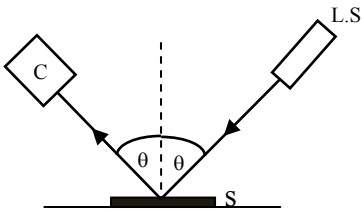


FIGURE 1. Setup for the IR photography to recover the contents from the burnt paper samples. C is IR camera, L.S is the IR light source, and S is sample and θ is an incident angle.

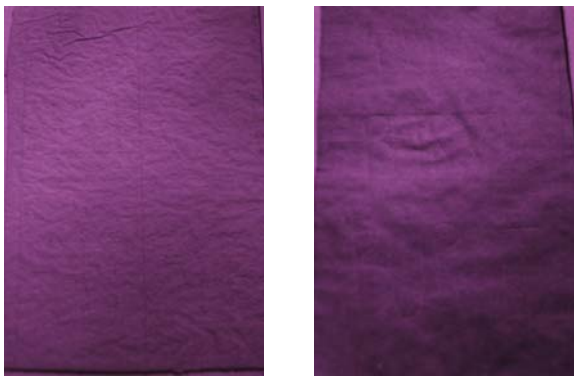
3. RESULTS AND DISCUSSIONS

The burnt paper samples are photographed with white light and IR light at different incident angles. The results depended on basis weight of paper, types of inks and burnt temperature.

At the same high temperature, colors of burnt papers were different due to the basis weight of papers. Lighter basis weight paper was observed to be wrinkled and lighter in color than the higher basis weight papers when photographed under white light. Under infrared light, only differences in wrinkles were observed (Figs 2 and 3).

(a) (b)

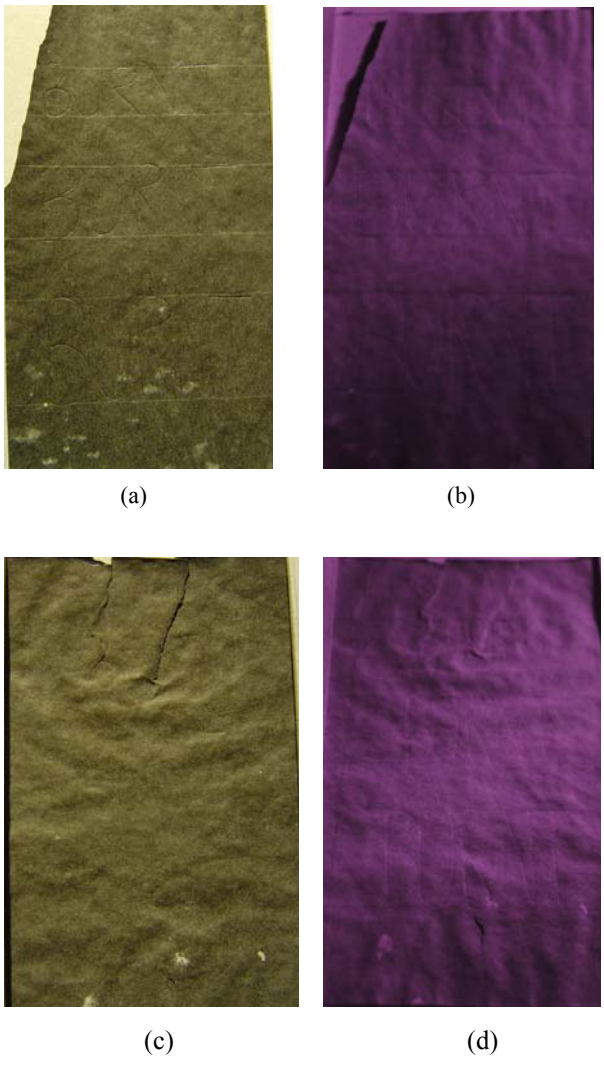
FIGURE 2. Comparison in visual color between 55 gram paper written by a ballpoint pen (a) and 80 gram paper (b) under white light, at T=380°C, and incident angle = 30°.



(a) (b)

FIGURE 3. Comparison in wrinkles of 55 gram paper (a) and 80 gram paper written by a ballpoint pen (b) under IR light, at T=380°C, and incident angle = 30°.

The results of IR photography on the written impressions from 80 grams papers were more clearly observed than those under white light, especially, the messages written by ballpoint pen and fountain pen. For ballpoint pen, the written impressions on papers burnt with both low temperatures (<350°C) and high temperatures (≥350°C) could be seen quite clearly. In case of paper samples with words written by a fountain pen, the written contents on the papers burnt at high temperature could be seen more clearly than the ones on the papers burnt at low temperature. That is the contrast between messages and paper occurred (Fig 4). Similar results could be observed from the contents written by a gel pen (Figs 5 and 6).



(a) (b)

(c) (d)

FIGURE 4. Showing 80 gram paper written by a ballpoint pen under white light (a) and infrared light (b), at T=350°C and incident angle = 60°. 80 gram paper written by a fountain pen under white light (c) and infrared light (d), at T=380°C and incident angle = 60°.

(a) (b)

FIGURE 5. Written messages by a gel pen on burnt papers at T=300°C the written contents could not be seen obviously under white light (a) and infrared light (b), incident angle = 30°.

The results relevant to the variation of incident angles from 15°-75° by stepping 15°clearly show that incident angles influence the degree of contrast between paper and written contents (Fig 6).

(a) (b)

Figure 6. IR photography of paper samples were written by a fountain pen and burnt at T=380°C observed at different incident angles: 15° (a) and 60° (b).

The incident angles adjustment could help to get more sharply and clearly contrast. This is confirmed by photographs (Fig 6) of the content visibility written by a fountain pen under 15° and 60° incident angles. This should be noted that in case of paper samples written by a ballpoint pen and a gel pen, the content visibility slightly depends on the angles of incidence. For a fountain pen, the written contents on burnt papers could not be seen until the incident angle is adjusted to an appropriate angle which usually is 60°.

4. CONCLUSION

Results obtained from the study indicate that the infrared reflected photography clearly show the potential of written contents recovery from burnt papers; especially 80 gram paper burnt at high temperatures (350°C-380°C). This should be noted that many factors such as burning temperatures, incident angles of a light source and type of ink can affect the content recovery from the burnt paper samples. From the study, contents written on papers burnt under high temperatures (>350°C) could be viewed under IR clearly. Also the suitable angles to photograph under IR light are about 60° because, at this incident angle, the contrast between the written contents and the background is more significantly different.

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