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TECHNICAL NOTE

Electronic fingerprinting of the dead

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Abstract To date, a number of methods exist for the capture of fingerprints from cadavers that can then be used in isolation as a primary method for the identification of the dead. We report the use of a handheld, mobile wireless unit used in conjunction with a personal digital assistant (PDA) device for the capture of fingerprints from the dead. We also consider a handheld single-digit fingerprint scanner that utilises a USB laptop connection for the electronic capture of cadaveric fingerprints. Both are single-operator units that, if ridge detail is preserved, can collect a 10-set of finger pad prints in approximately 45 and 90 s, respectively. We present our observations on the restrictions as to when such devices can be used with cadavers. We do, however, illustrate that the images are of sufficient quality to allow positive identification from finger pad prints of the dead. With the development of mobile, handheld, biometric, PDA-based units for the police, we hypothesize that, under certain circumstances, devices such as these could be used for the accelerated acquisition of fingerprint identification data with the potential for rapid near-patient identification in the future.

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Introduction

Fingerprinting is one of the four primary identification criteria that can be used in isolation to identify a deceased individual [1]. A number of techniques are available to recover fingerprints from cadavers [2–5]. With the development of biometric identification systems in the living has come the concept of a police officer being able to check the identity of an individual in the street using portable, handheld, biometric devices (http://www.crossmatch.net/single_finger_scanners.html; http://morpho.com/products_solutions/law_enforcement/RapID.html; http://www.identix.com/products/pro_mobile_ibis.html). They are based upon personal digital assistant (PDA) devices such as pocket PCs. Fingerprints and "mug shots" can be captured and stored for future analysis or sent by secure wireless communication to an automated fingerprint identification system (AFIS), i.e. near-patient testing. It is theoretically possible to undertake a 10-print search of 2.5 million individuals whose prints are on an AFIS using a handheld device in 40 s (Robert Gailing, personal communication, Cogent Systems, Pasadena, CA, USA).

The ability to apply electronic fingerprinting to cadaveric identification using Livescan units has been proposed previously [2, 6, 7]. However, to date, the use of mobile PDA-based systems has not been reported in the peer-reviewed literature. We report the use of two different electronic portable fingerprint capture devices with cadavers. We share our observations in relation to the present restrictions of such systems, which build upon those reported by Garrett [7]. We hypothesize that, with the

development of mobile, handheld, biometric, PDA-based units for use by the police, these units could be used with single or multiple fatalities for the accelerated acquisition of fingerprint identification data with the potential for rapid near-patient identification. For cadavers contaminated with chemical, biological or radiological agents, the use of powder techniques may not be appropriate [8]. Under these circumstances as the prints can be sent electronically, then systems such as the ones illustrated could be used to stop the removal and spread of contaminated material.

Materials and methods

Handheld fingerprint capture unit; live patient testing

A Cogent BlueCheck™ handheld fingerprint capture unit with Bluetooth-enabled Verizon Pocket PC® (Irvine, California, USA) containing Cogent MobileID™ software was used to capture all 10 finger pad prints of 10 healthy living volunteers (Fig. 1a). It is battery powered, weighs ~85 g and has a 500-dpi, 8-bit grayscale silicon sensor with SecurASIC technology for embedded encryption and image compression. The Bluetooth transfer distance is ~10 m, and an 8-MB Flash PDA memory card can store up to 8,000 fingerprints. Fingerprint capture is a single-operator procedure taking approximately 45 s to capture all 10 prints. Prints are sent by Bluetooth to the PDA unit where demographic information, for example, gender, race, stature, eye colour, weight etc. can be entered and associated with the print file.

Unlike Livescan units, this is true handheld, mobile device. However, as to date, the introduction of such units is limited, although the devices are designed for near-patient testing, this facility is not available in the UK. Thus, all images were downloaded by USB connection from the PDA to a Toshiba Portege Laptop (Toshiba, Tokyo, Japan) containing Cogent NistViewer™ version 2.1 software. This enabled a 10-print sheet to be printed (Fig. 1b), which for fingerprint comparison, this must be done at 1:1 sizing.

Handheld fingerprint capture unit; cadaver fingerprinting

The fingerprints of one male and four female cadavers were captured using the Cogent BlueCheck™. The cadavers were refrigerated before printing with a known time since death ranging from 1 to 6 days. Two additional male cases with mummified fingers and advanced decomposition and a severely burnt body with charring and pugilistic contractures of the hands were also investigated. Before image capture, finger rigor (where present) was broken, the pads dried of any moisture caused by refrigeration and the hands placed in a position to allow smooth transition from right to left hands during the fingerprinting process. No pre-treatment of the skin to enhance or recover ridge detail was undertaken.

Fig. 1 **a** The Cogent BlueCheck™ handheld fingerprint capture unit with Bluetooth-enabled Verizon Pocket PC®. **b** An example of a right thumb print acquired from a living volunteer with a Cogent BlueCheck™ unit and displayed with NistViewer version 2.1 (Cogent Systems)

Single-digit fingerprint scanner

Prints from 25 men and 20 women, aged 38–97 years old with a minimal post-mortem period of 1–24 days (this represents the known time since the body was admitted to the storage facility, but the body could have been dead for a longer time period than this), were captured with a Cogent single-digit fingerprint scanner (CSDFS; Cogent Systems; Fig. 2); 15 of which had black powder and inkless paper prints captured for comparison purposes. The CSDFS is a single-operator system with the time taken to capture the prints been approximately 90 s. It has a 500-dpi resolution and weighs 550 g, requiring a power supply and a USB connection with a laptop running LiveID software (Cogent Systems). Wireless capability is via the laptop (telephone, wireless network or satellite broadband).

Fig. 2 **a** The Cogent single-digit fingerprint scanner in use in a mortuary. **b** A right thumb print captured from a 65-year-old man with the CSDFS

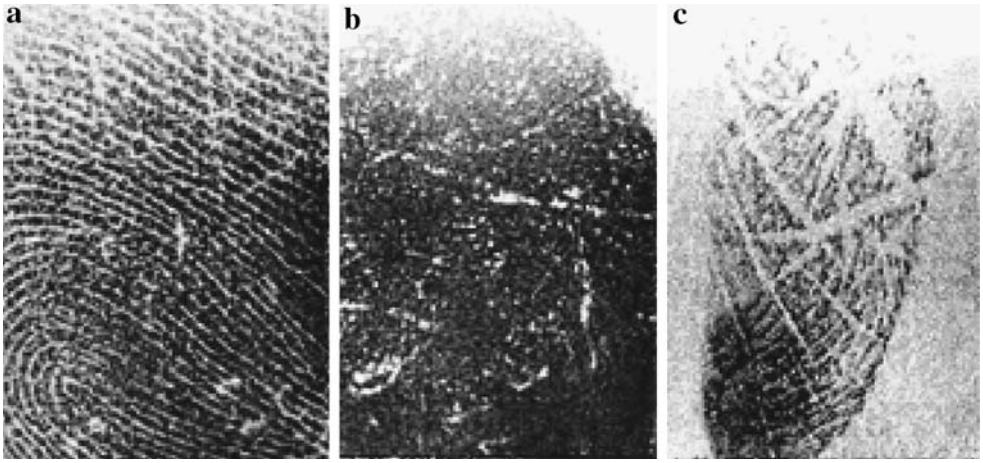

Fig. 3 Examples of right thumb fingerprints acquired from cadavers using a Cogent BlueCheck™ handheld fingerprint capture unit displayed with NistViewer version 2.1 (Cogent Systems). **a** Adequate print from an 82-year-old woman 2 days after death. **b** Inadequate print from an 85-year-old woman. **c** The side of the thumb of an elderly woman 1 day after death

Results

No pre-treatment to enhance ridge detail was undertaken in any case. For the CSDFS, the use of black powder before electronic printing was found to reduce image quality. For both units, print quality depended upon the age, gender and state of decomposition. Mummified fingers and advanced decomposition could not be printed with either unit, only those with ridge detail visible to the operators' naked eye. The severely burnt body (handheld unit only) could not be printed either by electronic or powder techniques.

With the Cogent BlueCheck™, grease, creams or sweaty fingers lead to the persistence of fingerprints on the scanner pad, which caused smudged or multiple images of later fingers. Drying the fingers with a cloth before capture overcame this problem. The capture unit was cleaned between individuals with a dry cloth or alcohol wipe. PDA-based fingerprint units are designed to capture the finger pads only. We tried printing the sides of the fingers, and although it is possible to acquire images, the unit is not designed for this. Unlike a Livescan unit, it is not large enough to capture palm detail, although toe pads could be captured. The CSDFS could capture sides, palms or toe images, but it is again designed for pads, not rolled prints.

The images from the living volunteers and cadavers were reviewed by police fingerprint officers. Where finger pad ridge pattern was present, it was considered to be of sufficient quality to allow a positive identification of an individual should their ante-mortem finger pad prints have been available for comparison. Examples of both adequate and inadequate prints are shown in Figs. 3 and 4.

Discussion

We believe that we have demonstrated the first use of a handheld, PDA-based biometric fingerprinting device for use for fingerprinting the dead. We also demonstrate the use and limitations of a single-digit fingerprint unit, building upon the scanty literature related to larger Livescan devices. This independently builds upon the work of the Scohomish County Medical Examiners department, USA who Garrett

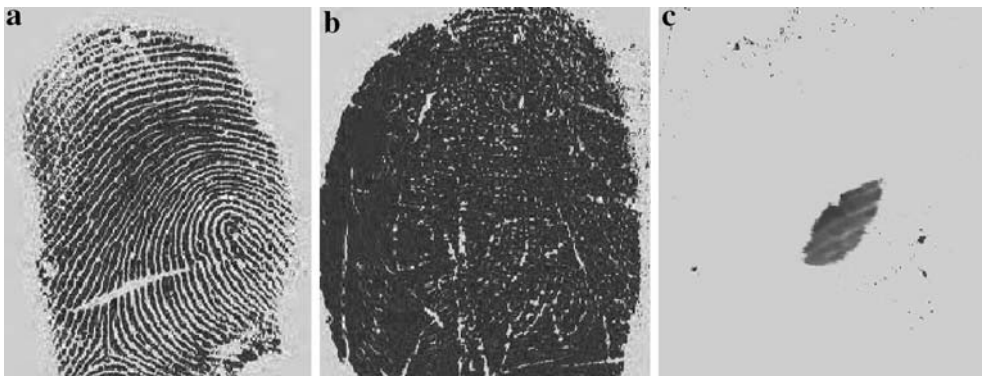

Fig. 4 Examples of right thumb fingerprints acquired from cadavers using a Cogent single-digit fingerprint scanner to illustrate adequate and inadequate prints. **a** Adequate prints from a 52-year-old woman at least 4 days post-mortem. **b** Inadequate print from a 56-year-old man at least 12 days post-mortem. **c** Inadequate print from the mummified fingers of a 69-year-old decomposed male corpse

reports have undertaken 421 sets of digital fingerprinting since 2005 with 43 positive identifications [7].

Garrett puts forward an argument why electronic fingerprinting systems such as Livescan could have advantages over powder printing of the dead. These include cost, speed of image acquisition and remote comparison (by e-mail with their system), the ability to observe the print process to acquire the best print and the ability to enter other demographic data into the database search. We agree with these observations, reporting that a full 10-set of fingerprints of a quality to allow identification can be acquired in 45 to 90 s (unit-dependent).

Although in our experience prints can be obtained from bodies where ridge detail is visible to the naked eye, both units could not acquire prints from bodies affected by fire or showing advanced changes of decomposition. Our observations differ to those reported by Garrett who describes the use of electronic fingerprint capture rather than traditional powder printing in bodies showing advanced decomposition. The use of techniques to enhance fingerprint collection remains untested to date. Investigations also still need to be undertaken using electronic units that can acquire rolled prints.

PDA units could be used both within a mortuary or scene of crime to acquire and transmit prints to an AFIS system for true near-patient identification, although limitations still exist in both availability and composition of these units. However, with the introduction of such devices to police officers for live person near-patient identification, this situation is likely to change in the near future (http://news.bbc.co.uk/1/hi/uk/6170070.stm). PDA-based units could be used on the discovery of deceased individuals or in instances of mass fatalities for the rapid acquisition of fingerprint identification data. In mass fatality incidents, devices such as this could be used instead of powder printing when bodies are contaminated by chemical, biological or radiological agents and where, under such circumstances, traditional powder printing by fingerprint officers may not be undertaken. The availability of an easy-to-use, handheld PDA system that allows for the collection of large numbers of fingerprints for transmission for remote storage and analysis has an obvious use in such circumstances.

Thus, in summary, our work builds upon that of previous investigators and illustrates the use of a mobile PDA-based system for cadaveric fingerprinting. To date, the system does not replace the need for traditional powder printing due to the effect of decomposition on print quality, but these units do add to the armoury of those that identify the dead.

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