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Adziri Sackey
UNIVERSITY OF GHANA, College of Health Sciences, School of Medicine and Dentistry
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IMAGING

A Low-Cost High-Quality Mobile X-ray Film Digitiser with Storage Facilities

Adziri H. Sackey[1]

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Abstract

Digitisation of X-ray films reduces need for storage space and facilitates remote diagnosis, personal collections, teaching and publication. We describe a system that provides high-quality digitisation of X-ray films, especially suitable for low resource countries. The system comprises of a bespoke mobile cabinet with flat top-surface and lockable wheels, an X-ray viewing box, a small tripod, a good-quality digital camera and a computer with simple photo editing software. Compared to commercial digitisers, this system is much cheaper, uses local materials, provides employment for local people, is more physically and electrically robust and durable. It provides storage space, requires minimal training, and the components can be used for other purposes.

Keywords Digitisation of X-rays · Low-resource countries · Low-cost · Low-income countries

Digitisation of X-ray films reduces need for storage space and facilitates remote diagnosis, personal collections, teaching and publication [1–4]. There are many commercial units available costing between USD10–20,000 excluding maintenance, servicing, repairs, software and training costs [1, 5]. Alternatively, satisfactory results may be obtained by expertly photographing an X-ray, mounted on a viewing box, using a hand-held digital camera [1, 4]. However, when using a wall-mounted viewing box, the image may be marred by reflections from sources of bright light, especially windows.

We describe a simple low-cost device which provides high quality digitisation of X-ray films as well as storage space and mobility. The device is a cabinet with flat top-surface and lockable wheels (Figs. 1 and 2). At one end of the top-surface is a slot for an X-ray viewing box, and at the other end are three indentations to hold a tripod. The cabinet contains two padded shelves, one of which has a partition for securing the X-ray viewing box when the cabinet is being moved. The rest of the cabinet space is available for storage of a camera, tripod and other items.

The cost would be about 1500–2000 US dollars, depending on the quality of materials, workmanship and camera used. For high-quality output, the camera must have a slot for mounting on a tripod; desirable features include a zoom lens and selectable ISO, aperture and exposure time. High-cost features such as small size, speed of focusing, number of frames per second and video capability are not required. Suitable examples include new or used entry-level digital SLR cameras such as the Nikon D3400 and Canon EOS Rebel T6 among many others.

To use:

1. The camera is attached to a tripod.
2. The tripod legs are inserted into the slots provided.
3. The viewing box is placed in its slot on the top of the cabinet.
4. The X-ray film to be digitised is placed on the viewing box and secured with the attached clips.
5. The lights in the viewing box are turned on.
6. The cabinet should be positioned to avoid visible reflections on the Xray film.
7. The camera is turned on and its lens zoomed in order to frame the desired image.
8. The picture is taken and image transferred to a computer for editing.

This article is part of the Topical Collection on *Imaging*

✉ Adziri H. Sackey
sackey@sky.com

[1] Department of Child Health, School of Medicine and Dentistry, College of Health Sciences, University of Ghana, Accra, Ghana

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Fig. 1 The bespoke mobile cabinet

Compared to this low-tech manual device, a commercial unit may offer faster throughput with mostly unattended operation and smaller size [6].

However, this manual device is much cheaper, uses more local materials, provides employment for local people, is more physically and electrically robust and durable; is more mobile and also provides storage. Training costs should be minimal for individuals with basic education.

The use of a tripod enables acquisition of high resolution sharp images by enabling long exposure times which then allow use of the camera's base ISO and the lens' optimum aperture. However, Whitehouse recommends a shutter speed faster than 1/50th second to avoid flickering from the light source of a standard viewing box [7]. Camera shake can be reduced further by using a self-timer, either external or in-built. Use of an intervalometer, built-in or external, set to operate at intervals of say 10 s, enables a single operator to work efficiently by concentrating on changing the X-ray films whilst the camera operates automatically. Image quality can be further enhanced by covering exposed parts of the X-ray viewing box, that is, parts not covered by the film, with an opaque material to avoid under-exposure by the camera's metering

Fig. 2 The system's cabinet showing two padded shelves

Fig. 3 A digitised 10 year old X-ray film

Fig. 4 A digitised 35-year-old film

system. The alternative to the masking described above is to increase the exposure manually, if available. Experimentation with the first few shots would help determine the exact settings. The mobility of the device allows the operator to point the viewing box and X-ray film away from bright lights to minimise reflections, and also permits use in multiple locations. Once the digital image has been acquired, editing software can be used for cropping, lighting adjustment and annotations as required. Figures 3 and 4 are compressed images of old films. The images are free of reflections and other artifacts and can enhanced further with software, if required, to highlight particular features.

A further use of the device is digitisation of material written on a loose sheet of paper. The sheet is clipped onto the viewing box with its lights off, and photographed; flash may be deployed as necessary.

Lastly, the camera and other components can be used for other purposes when not required for digitisation.

Compliance with Ethical Standards

Conflict of Interest The author declares no conflict of interest.

Ethical Approval Ethical approval is not applicable for this study.

Informed Consent Informed consent is not applicable for this study.

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