Scientific Examination Report

Examining the influence of the photo angle on the sizes of wounds 1(a) and 1(b)

Report prepared by Prof CC Theron, Head Physics Department, University of Pretoria, 25 September 2013.

Background

Inge Lotz' autopsy report states that the sizes of wounds 1(a) and 1(b) are both 30 mm in diameter. The autopsy photo of these wounds show them as around 20 mm in diameter.

The defence claimed that the photo was taken at such angle that the wound sizes were distorted from 30 mm down to 20 mm on the photo, and that the scale could therefore not be trusted.

This reports aims to determine a scale for evaluating the size of wounds 1(a) and 1(b) and to confirm their actual sizes.

Determining a scale for evaluating the size of wound 1a

I have used the image of a 300 mm Shinwa ruler (see Appendix: Shinwa Ruler) in the photograph to determine the position and orientation of the camera lens (focal length = 6 mm) with respect to the ruler. The definitions of the axes used are given in Figure 1. The origin was chosen at the edge of the 125 mm graduation that faces the camera. The lens is placed at position $\vec{l}$, and the orientation of the lens at this point is given by indicating the normal vector $\hat{n}$ of the lens plane, using two angles (θ and ϕ) as seen in Figure 2. Negative values of θ imply a clockwise rotation around the z-axis, while positive values of ϕ are rotations from the x-y plane to the positive z-axis.

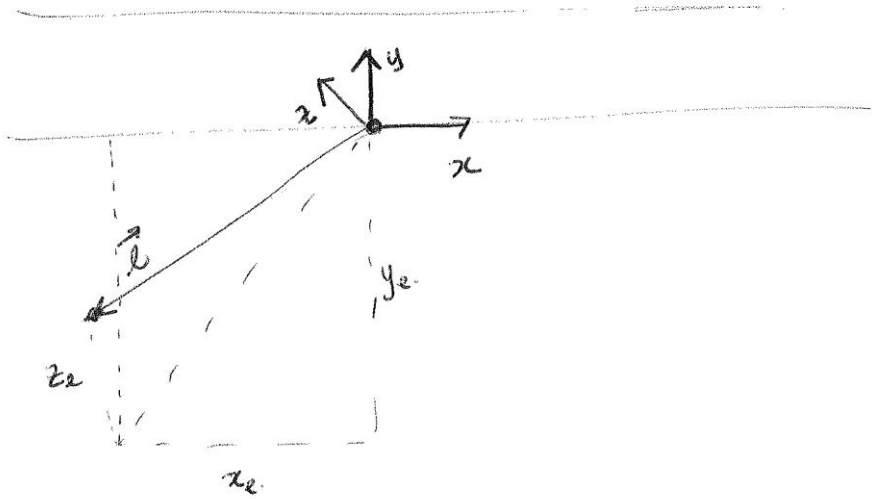

Figure 1: Definition of axes used in the analysis

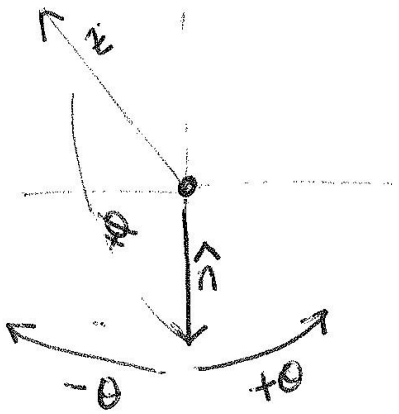

Figure 2: Definition of the normal to the lens plane

Using a thin lens model for the camera, but avoiding paraxial approximations, the position and orientation of the camera were determined relative to the chosen origin (the 125 mm mark). The results are tabulated in Table 1. The extra parameters m and ω denote a CCD magnification factor and a CCD in-plane rotation needed to match the pixel data, and are shown only for interest as they do not affect the camera lens position.

Table 1: Camera position and orientation

Parameter	Value
x_l	-28 cm
y_l	-24 cm
z_l	+93 cm
θ	-1.108 rad or -63°
ϕ	+1.010 rad or 58°
m	1008
ω	3.171 rad

The accuracy of fitting the ruler to the image is shown in Figure 3, where the blue crosses denote the pixel value of a particular graduation mark on the ruler (obtained by digitization of selected places that were fully visible), and the circles are calculated pixel marks based on the position and orientation of the camera and a knowledge of the ruler dimensions.

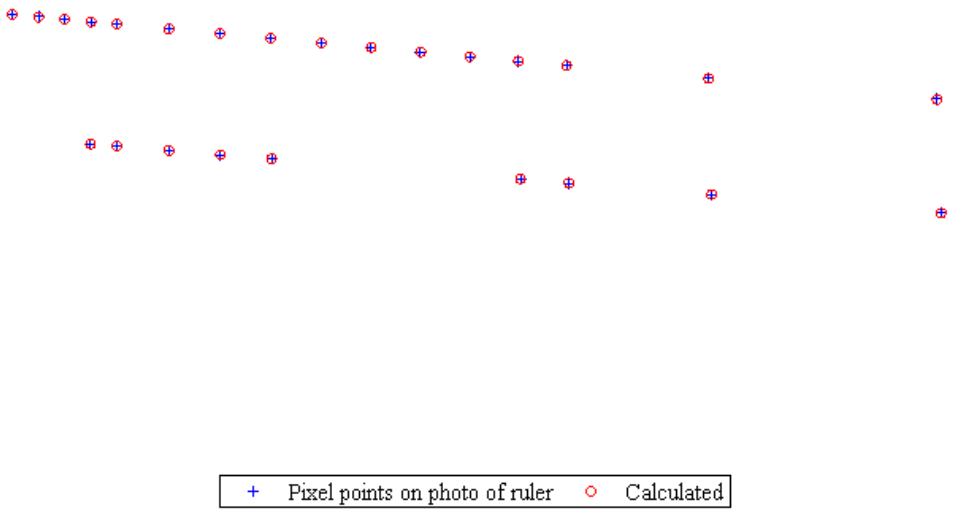

Figure 3: Accuracy of determining the camera position and orientation

I was now in a position to move the ruler around in the scene. Based on the photograph I assumed that moving the ruler 3 cm towards the viewer (-3 cm in y) and lifting it upwards by 4 cm (determined by trial and error until the line of the ruler intersected with wound 1b), would place it much closer to the actual position of wound 1b. I then calculated the cm mark spacings and displayed these on the photograph (I shifted the ruler by 2 mm in the x-direction to get a mark in the centre of wound 1b). This is shown in Figure 4.

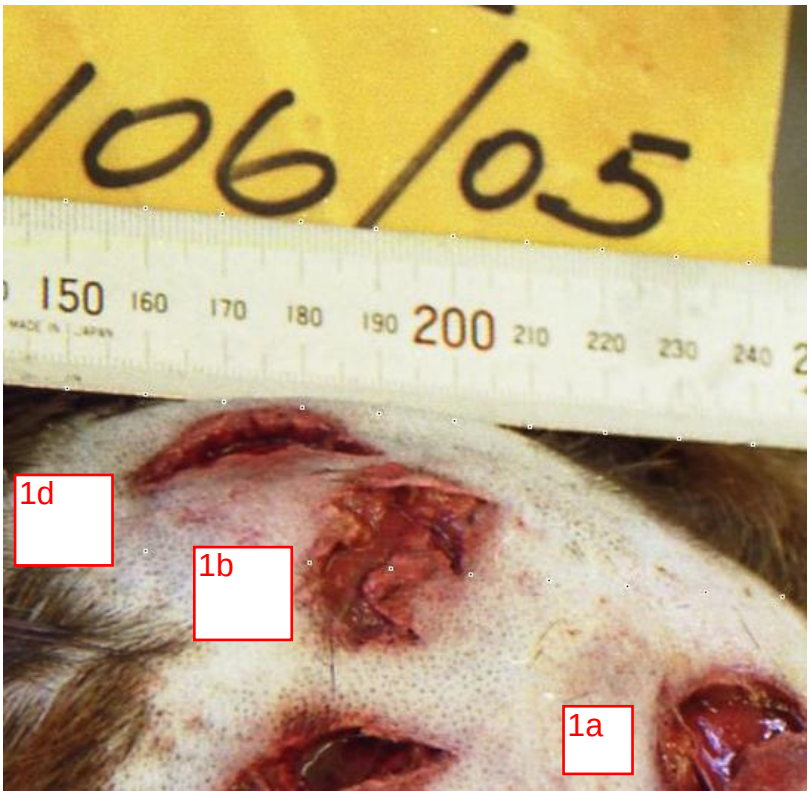

Figure 4: 1 cm spacing marks shown as white squares, calculated by moving the ruler edge 3 cm towards viewer and 4 cm upwards (relative to original ruler position).

The results show that the redrawn spacing markers are about 9% wider than those on the image of the ruler (this is due to the fact that if the ruler is positioned anywhere on top of the head, it will be nearer to the camera and must take up more pixel space in the image). The camera angle in this case plays a minimal role, as it distorts both the original ruler and the displaced ruler. The width in the x-axis is also not affected by the fact that the wound plane and the ruler plane are not necessarily the same. The width of wound 1b, depends slightly on the exact value (assumed -3 cm in y) of the ruler displacement. However, it can never be larger than what can be estimated by the original ruler position. The dimensions of the wound are consistent with an object that has a striking face of ±20 mm in diameter and not a ±30 mm object.

Shinwa ruler dimensions

■ Aluminum Cutting Rule

Item Code	Description of Goods	Size (L×W×T)	Weight	Box	JAN Code
33279	12inch	310×35×5	52g	20	4 960910 332799
33295	24inch	610×35×5	106g		4 960910 332959

Inch only

12inch

●Straightness
12inch : within±0.3mm
24inch : within±0.6mm

※Straightness means the side warp

Lightweight

Easy-to-read scale marks

Drawing guide groove

Cutting guide edge

Non-slip sponge (Backside)

■ Round End Stainless Rule

H : Hard Chrome Finish

Item Code	Description of Goods	Graduation	Size (L×W×T)	Weight	Box	JAN Code
23001	H-301A	150mm×6"	175×15×0.5	10g	50	———

Type	Graduation			
	Front		Back	
	Upper	Lower	Upper	Lower
301	0.5mm mm	1/16",1/32",1/64"	Conversion Table	

Polish Finish available
Production according to JIS standard

Metric × Inch

H-301A

H : Hard Chrome Finish

Item Code	Description of Goods		Graduation	Size (L×W×T)	Weight	Box	JAN Code
13005 (21013)	H-101A	JIS	150mm	175×15×0.5	10g	50	4 960910 130050
13013 (21086)	H-101C	JIS	300mm	335×25×1.0	65g		4 960910 130135
13021 (21030)	H-101E	JIS	600mm	640×30×1.2	180g	10	4 960910 130210
13048 (21108)	H-101F	JIS	1000mm	1,050×35×1.5	425g		4 960910 130487
13056 (21590)	H-102G	JIS	1500mm	1,565×40×2.0	950g	5	4 960910 130562
13064 (21608)	H-102H	JIS	2000mm	2,065×40×2.0	1,250g		4 960910 130647

Type	Graduation			
	Front		Back	
	Upper	Lower	Upper	Lower
101	mm	0.5mm	Conversion Table	
102	mm	0.5mm	Plain	

JIS : JIS (Japanese Industrial Standard) MARK

Metric only

H-101A

H-101F

The size of the ruler in the picture is assumed to be that of the 300mm graduation, viz 335x25x1.0 mm (Length*Width*Thickness) H·101C.