Notes

109.32 Caravaggio's camera

In a nice back-of-envelope application of the venerable thin-lens equation of geometrical optics, Hockney and Falco [1] estimate the focal length f of an old master painting, Lorenzo Lotto's *Husband and Wife* (1523), their interest being in recreating the sort of auxiliary optical setup Lotto and his Renaissance contemporaries seemingly used to achieve camera-like detail and perspective.

The thin-lens equation relates f to the distances d from camera centre to object (o) and image (i) as

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \tag{1}$$

which Hockney and Falco solve for f by substituting a magnification $m = d_i/d_o$ estimated from the wife's shoulder span, along with a d_0 consistent with conjectured dimensions of Lotto's studio. The latter is necessarily a little *ad hoc*, but fine for the purpose of a ballpark order of magnitude, verifying that Lotto's painting is consistent with the uncomplicated use of an inexpensive concave mirror or biconvex lens of a diopter or so.

Here in a similar spirit we estimate the focal length of another painting, *The Lute Player* (1596) by Caravaggio, which is on the Cover of this issue. The artist is likewise believed to have been at the forefront of historical developments in auxiliary optics [2]. The titular lute is in three-point perspective, and this can be exploited to obtain a more quantitative estimate than that for the Lotto.

The ticket is the construction shown in Figure 1. Given vanishing points (VP) in an image corresponding to three orthogonal directions in the 3D space of the scene, we connect them to form a triangle and 'drop the altitudes' (lines through *PP*) to locate its orthocentre. Caprile and Torre [3] have shown that (i) the orthocentre is equivalently the camera's principal point (*PP*), the point in the image lying perpendicularly opposite the camera centre, and (ii) the lengths q, r of the segments that the orthocentre divides an altitude into determine

$$d_i = \sqrt{qr}. \tag{2}$$

Note that it doesn't matter which altitude is chosen, the product of lengths q, r is the same for all three.

To apply this to Caravaggio's *The Lute Player*, in Figure 2 we have annotated three orthogonal axes of the lute to which we can associate vanishing points. Of these, VP_{bridge} at the apparent intersection of bridge and nut lines (which are parallel in the 3D space) is straightforward, but the other two require slightly more involved treatment. VP_{pegbox} is found via a 'quadrilateral construction, subject to the assumption of regular spacing of the pegs, while VP_{neck} is found from the foreshortening distortion $a' : b'$ of

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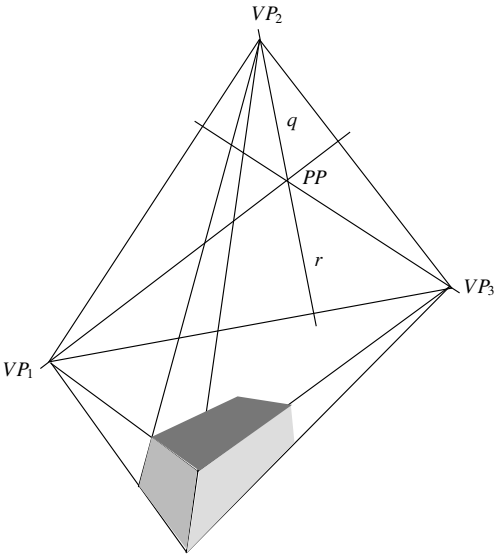


FIGURE 1

a known length ratio $a : b$. For the known length ratio in this case we use the position of a fret, relative to nut and bridge respectively (the 8th fret is particularly clearly visible in the painting). Details of these latter two types of construction may be found in introductory textbooks on projective geometry such as [4].

The vanishing points thus determined are drawn in Figure 3 relative to the canvas, size 94cm × 119cm. Applying (2), we get $d_i \approx 2$ metres.

To complete our objective of estimating a focal length for Caravaggio's auxiliary optics, we note that the face of the lute player is near life-size on the canvas, hence magnification $m = d_i / d_0$ is roughly unity, and we have $d_o \approx d_i \approx 2$ metres. Substituting these d_i. d_o into (1) we arrive at $f \approx 1$ metre, optical power 1 dpt, that of a typical spectacle lens.

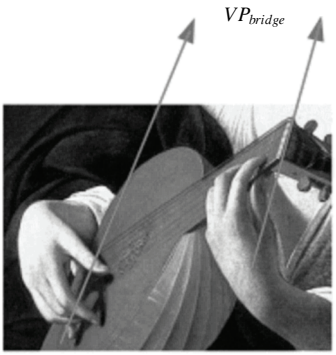


FIGURE 2(a)

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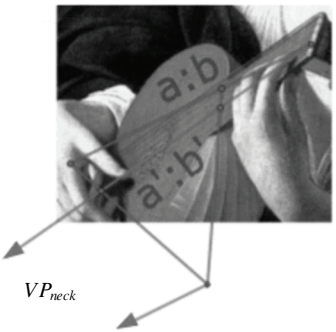


FIGURE 2(b)

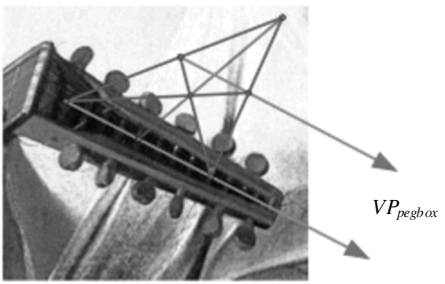


FIGURE 2(c)

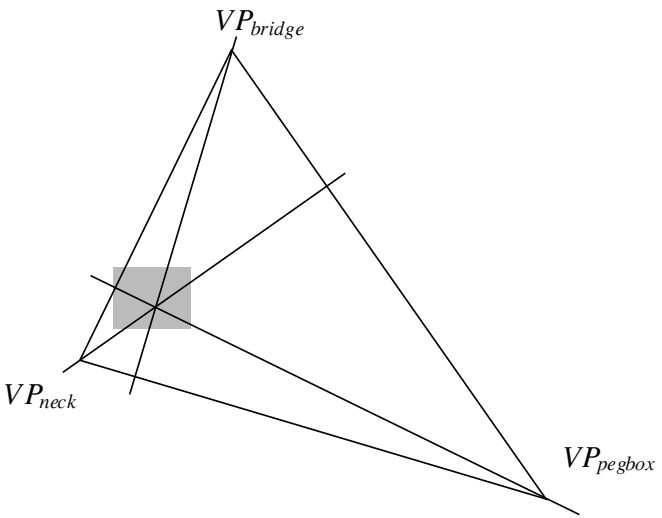


FIGURE 3

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References

1. D. Hockney and C. M. Falco, *Optical insights into Renaissance art. Optics and Photonics News*, **11**(7) (2000) pp. 52-59.
2. R. Lapucci, *Caravaggio e l'ottica*. Rest & art, Firenze (2005).
3. B. Caprile and V. Torre, Using vanishing points for camera calibration. *International Journal of Computer Vision*, **4**:127 (1990).
4. H. S. M. Coxeter, *Projective geometry*, Springer (1987).

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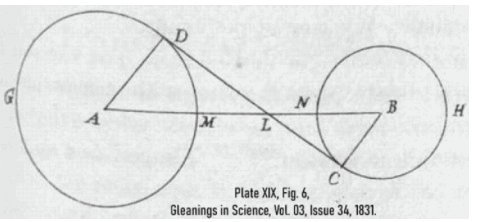
NICHOLAS BRAUN
Gamla Folkskolans Ateljéer,
Kyrkhamn, SE-16572 Sweden
e-mail: *f.n.braun@gmail.com*

109.33 Radhanath Sikdar: the Bengali mathematician overlooked during his lifetime

Radhanath Sikdar, a gifted Bengali mathematician, was born in October, 1813 in Kolkata. Due to financial constraints, he attended a local school but secured a scholarship due to his outstanding intellect. He went on to enrol at Hindu College, Calcutta, in 1824 (now Presidency University). In 1830, he commenced his studies under the tutelage of the distinguished mathematician John Tytler at the same institution. When he was a student at the Hindu College in Calcutta, he invented a new way of drawing a common tangent to two circles which was published in *Gleanings in Science* [1].



Radhanath Sikdar



Sikdar's diagram [2]

Here, we discuss his method briefly:

Let DMG and HNC be two circles with the centres A and B respectively. Join AB. Divide AB at the point L in such a way that $\frac{AL}{LB} = \frac{AM}{NB}$.

Draw a line LD such a way that it touches the circle GMD at the point D. Then join A and D and draw a line segment BC parallel to AD, where C is the point on the circumference of the circle CNH. Next join L and C.

Since $AD \parallel CB$, so $\angle DAM = \angle CBN$ and $\frac{AL}{LB} = \frac{AM}{NB} = \frac{AD}{CB}$; hence, the triangles ALD and BLC are similar. Thus $\angle BCL = \angle ADL = 90°$. Hence LC touches the circle CNH at the point C and consequently DC becomes a tangent to both circles.

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