# Homework 2023-2024

Scene. A **right circular cylinder** together with two (or more) circular **cross sections** and two (or more) **generatrix lines**. *A right circular cylinder is a surface, made of parallel lines, which is symmetric about a symmetry axis. A circular cross section of a right cylinder is a circumference centered on the symmetry axis and perpendicular to the symmetry axis. A generatrix line is a straight line, on the cylinder surface, which is parallel to its axis.*
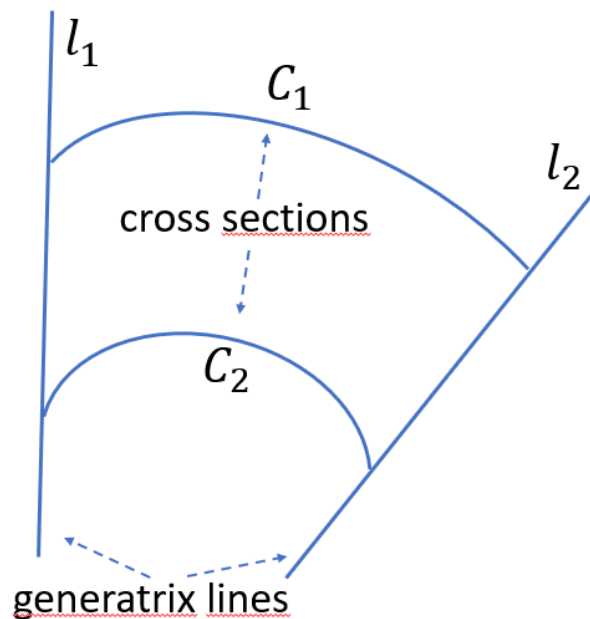

Image. A single image is taken of the above described cylinder by an uncalibrated, zero-skew, camera. (*Its calibration matrix depends on **four** unknown parameters, namely f_x, f_y and the two coordinates U_o, V_o of the principal point*). Two circular cross sections are visible, and their images C_1, C_2 are extracted. Two (parallel) generatrix lines of the cylinder are also visible, and their images l_1, l_2 are extracted.

Part 1: **Theory**

1. From C_1, C_2 find the horizon (vanishing) line h of the plane orthogonal to the cylinder axis.
2. From l_1, l_2, C_1, C_2 find the image projection a of the cylinder axis, and its vanishing point V.
3. From l_1, l_2, C_1, C_2 (and possibly h, a, and V), find the calibration matrix K.
4. From h, K, and V determine the orientation of the cylinder axis wrt the camera reference.
5. Compute the ratio between the radius of the circular cross sections and their distance.

Part 2: **Matlab**

1. Consider the image PalazzoTe.jpg. Using feature extraction techniques (**including** those implemented in **Matlab**) plus possible manual intervention, extract both the images l_1, l_2 of useful genetrix lines and images C_1, C_2 of useful circular cross sections.
2. Write a Matlab program that implements the solutions to problems $1-5$
3. Rectification of a cylindric surface: Plot the **unfolding** of the part of the surface, included between the two cross sections, onto a plane.
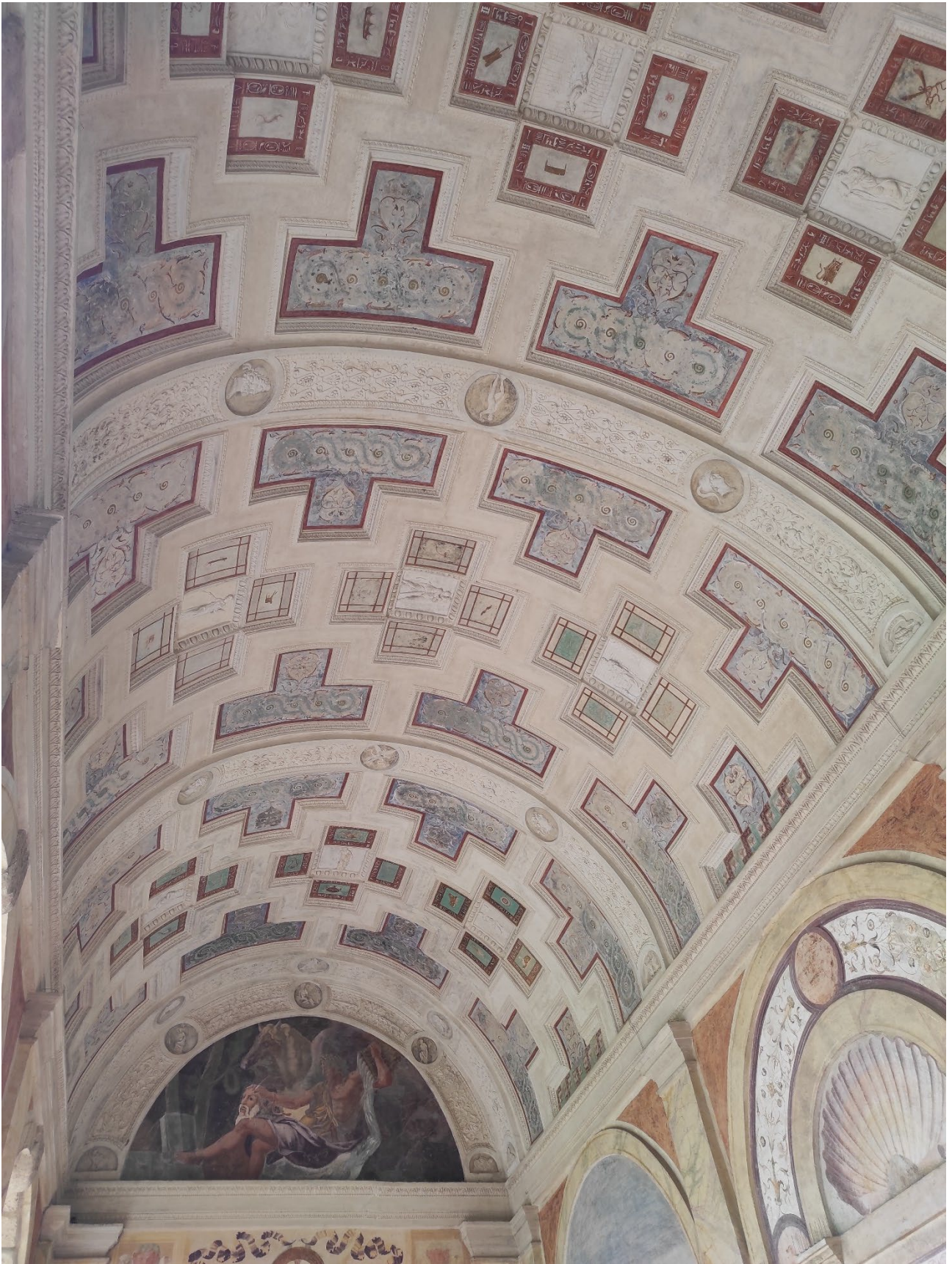
A cylindrical voult in Palazzo Te - Mantova