《计算机辅助几何设计》作业

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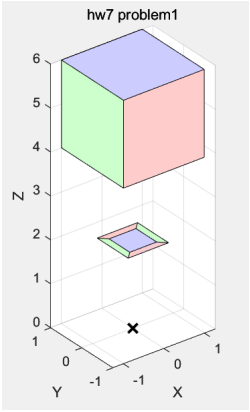
1. Program and draw a perspective projection of a cube with center x and side length 2d on a 2D plane, where point x and the value of d are specified by the user. Make reasonable assumptions about camera parameters and orientation.

我选的相机位置为(0,0,0)，平面为垂直于z轴，朝向立方体的方向，平面的z坐标也作为输入参数。

结果



2. Draw an ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ and a hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ using rational quadratic B´ezier splines, with as few segments as possible. Parameters a and b are specified by the user.

3. In 3D space, draw the B´ezier curves from the previous problem represented in homogeneous coordinates (i.e., the three-dimensional curves before projection transformation).

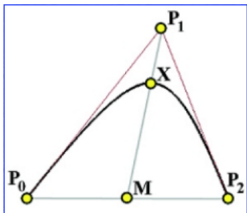
实验思路

根据课上推导，二次有理Bezier曲线可以表示为：

$$B(t) = \frac{(1-t)^2 P_0 + 2t(1-t)wP_1 + t^2 P_2}{(1-t)^2 + 2t(1-t)w + t^2}$$

根据平移不变性，不妨设$P_0 = -P_2$，则有

$$B(0.5) = \frac{wP_1}{w+1}$$



设P_0P_2的中点为M，P_1M与有理Bezier曲线的交点为X，则有：

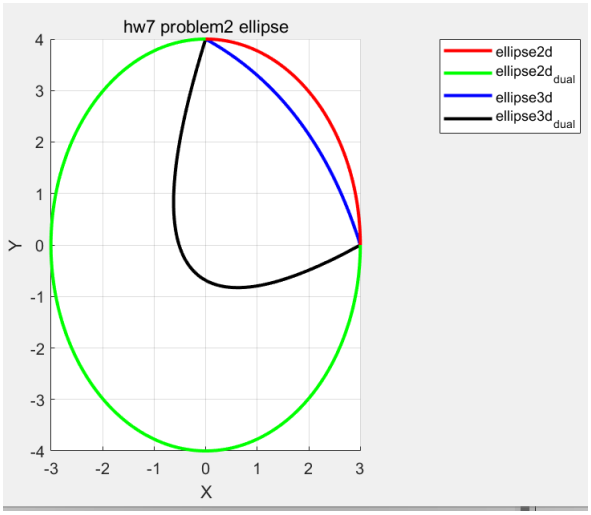
$$\frac{MX}{MP_1} = \frac{w}{1+w}$$

选定控制点后，根据上述公式求得w，然后带入求出曲线即可。取$-w$时即为共轭曲线

结果

0.1 ellipse

选取控制点为$P_0(a,0), P_1(a,b), P_2(0,b)$，求得$w = \frac{\sqrt{2}}{2}$。



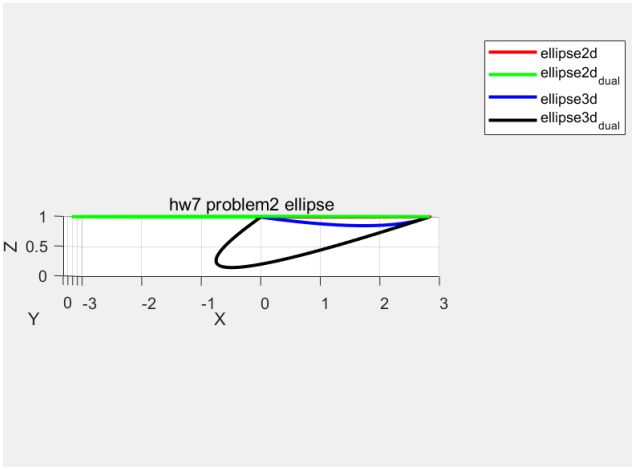


图 1: ellipse,a=3,b=4

0.2 hyperbola

选取控制点为$P_0(c,-\frac{b^2}{a}),P_1(\frac{a^2}{c},0),P_2(c,\frac{b^2}{a})$，求得$w=e=\frac{c}{a}$。

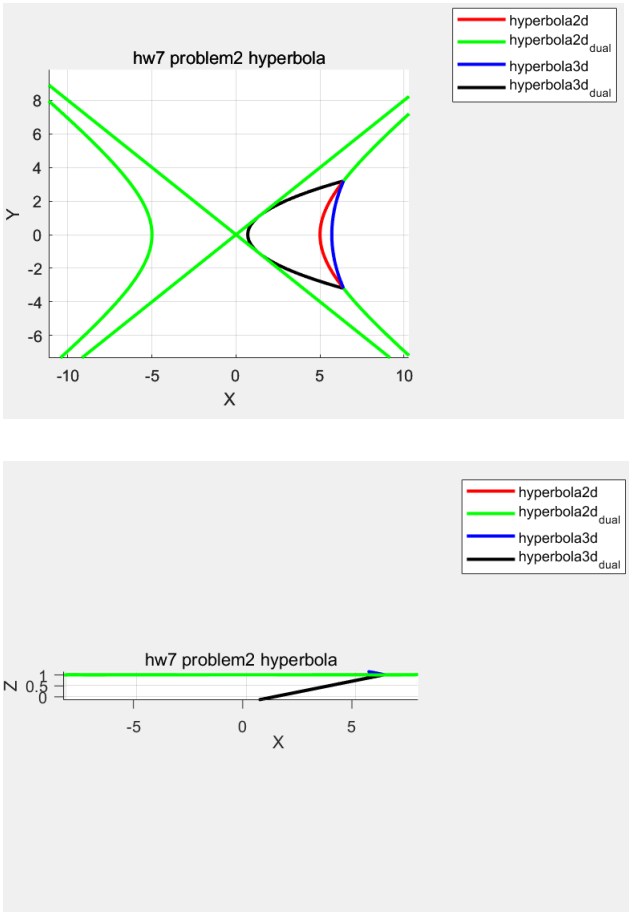


图 2: hyperbola,a=5,b=4