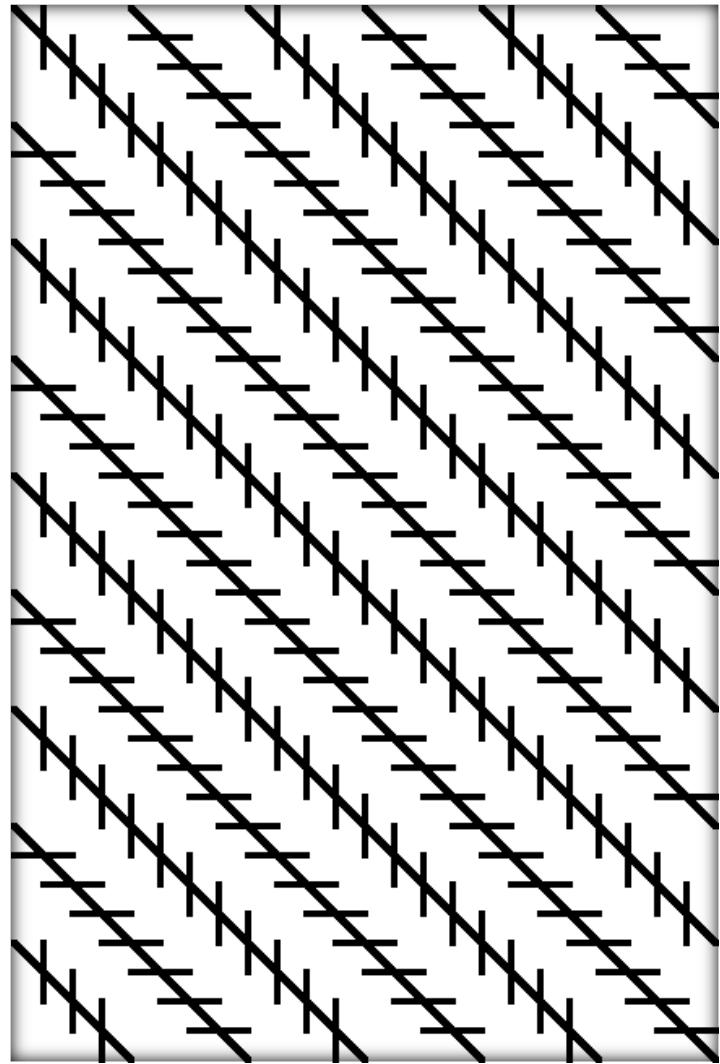


Računalniška grafika

projekcije

OPTIČNE ILUZIJE



optične iluzije

perspektiva



3D street art
the crevasse



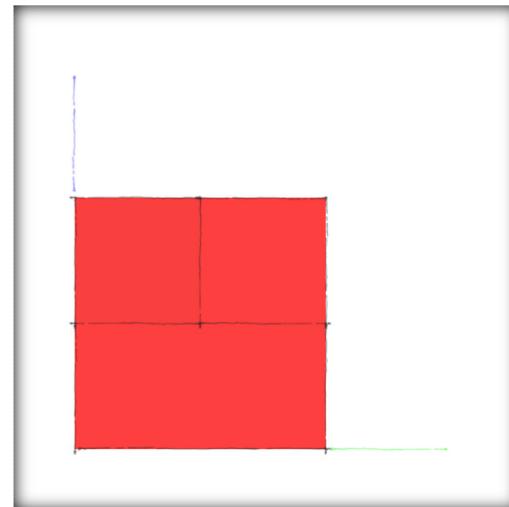
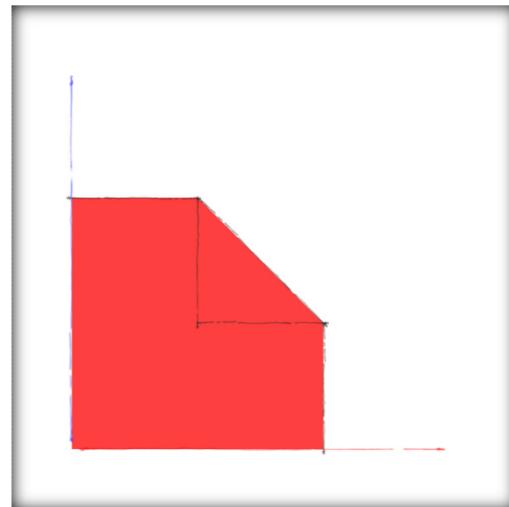
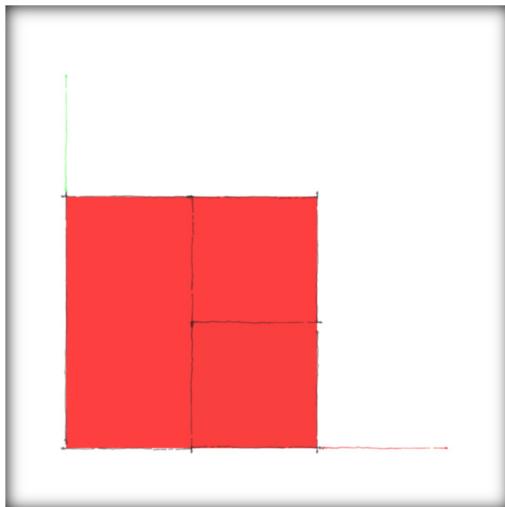
PROJEKCIJE

projekcije

vzporedne

pravokotne

od zgoraj
čelna
stranska

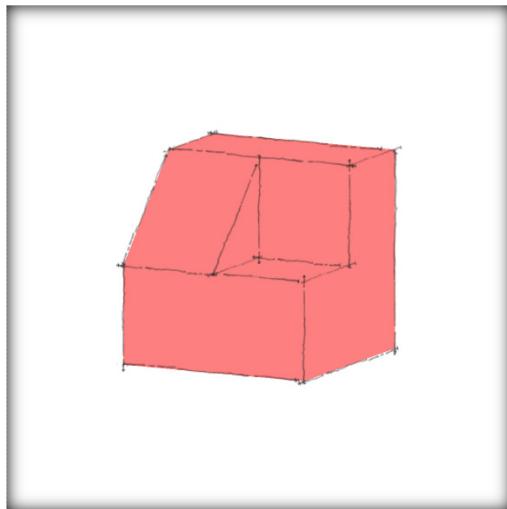


projekcije

vzporedne

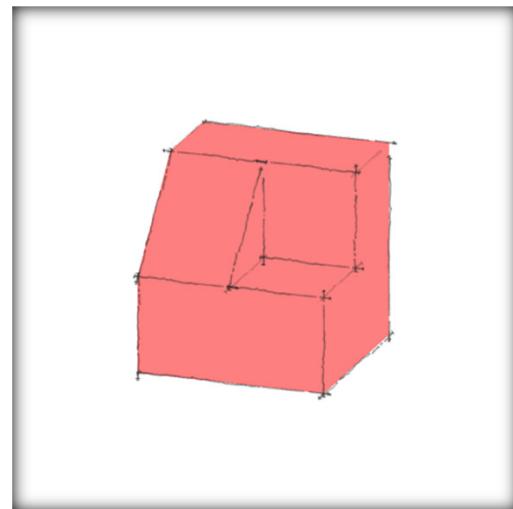
pravokotne

aksonometrične
trimetrične
dimetrične
izometrične



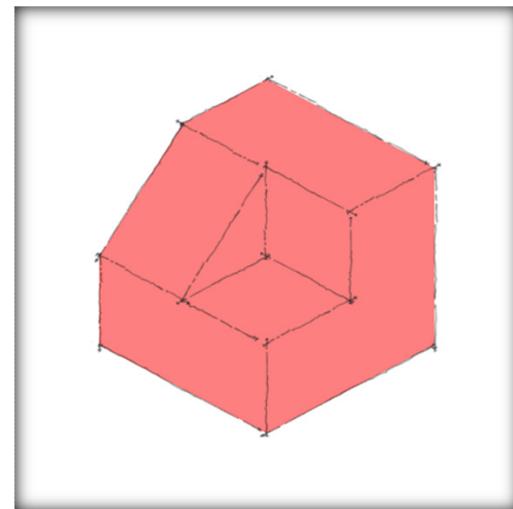
0,9:0,5:1

$\alpha \neq \beta \neq \gamma$



1:0,5:1

$\alpha = \beta \neq \gamma$



1:1:1

$\alpha = \beta = \gamma$

projekcije

vzporedne

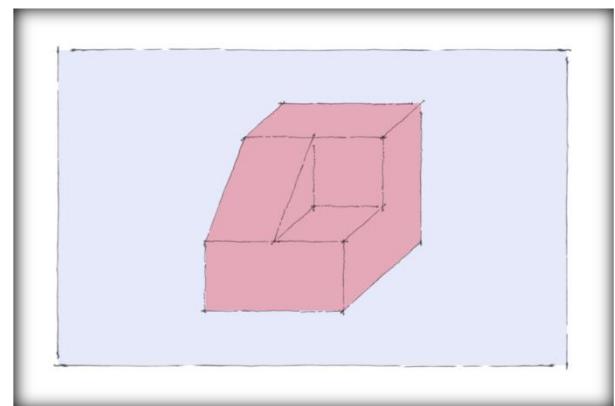
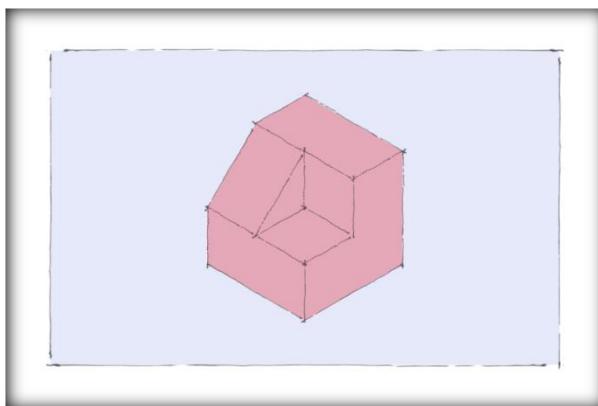
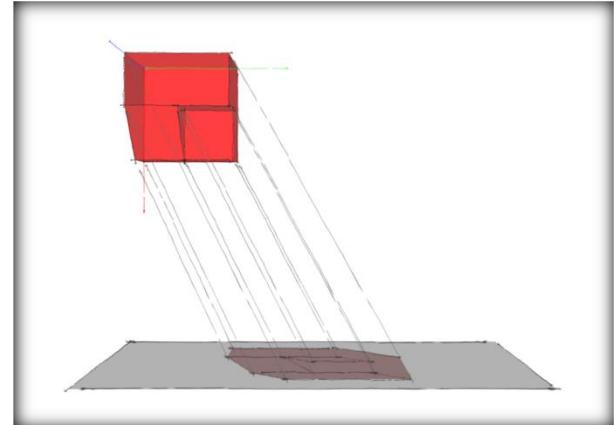
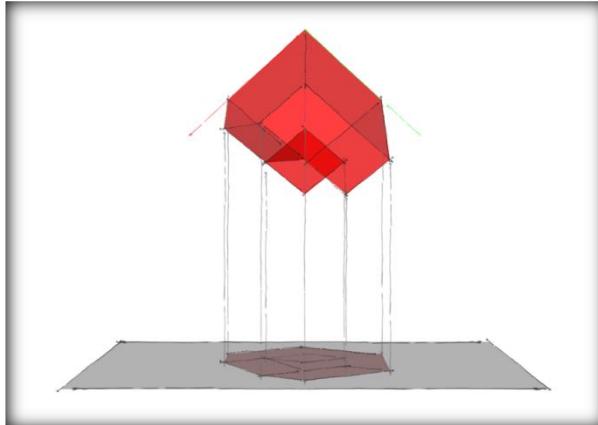
pravokotne

aksonometrične

poševne

kavalirska

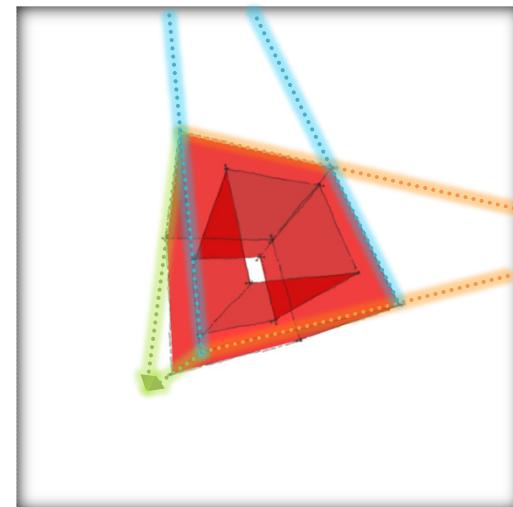
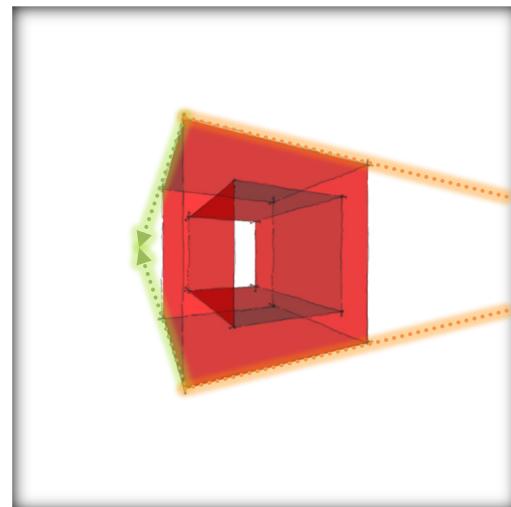
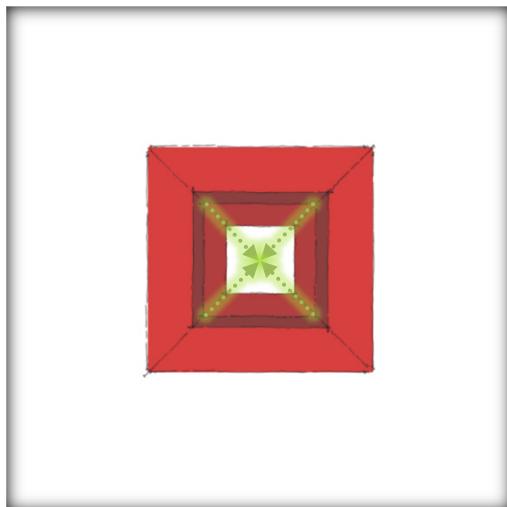
kabinetna

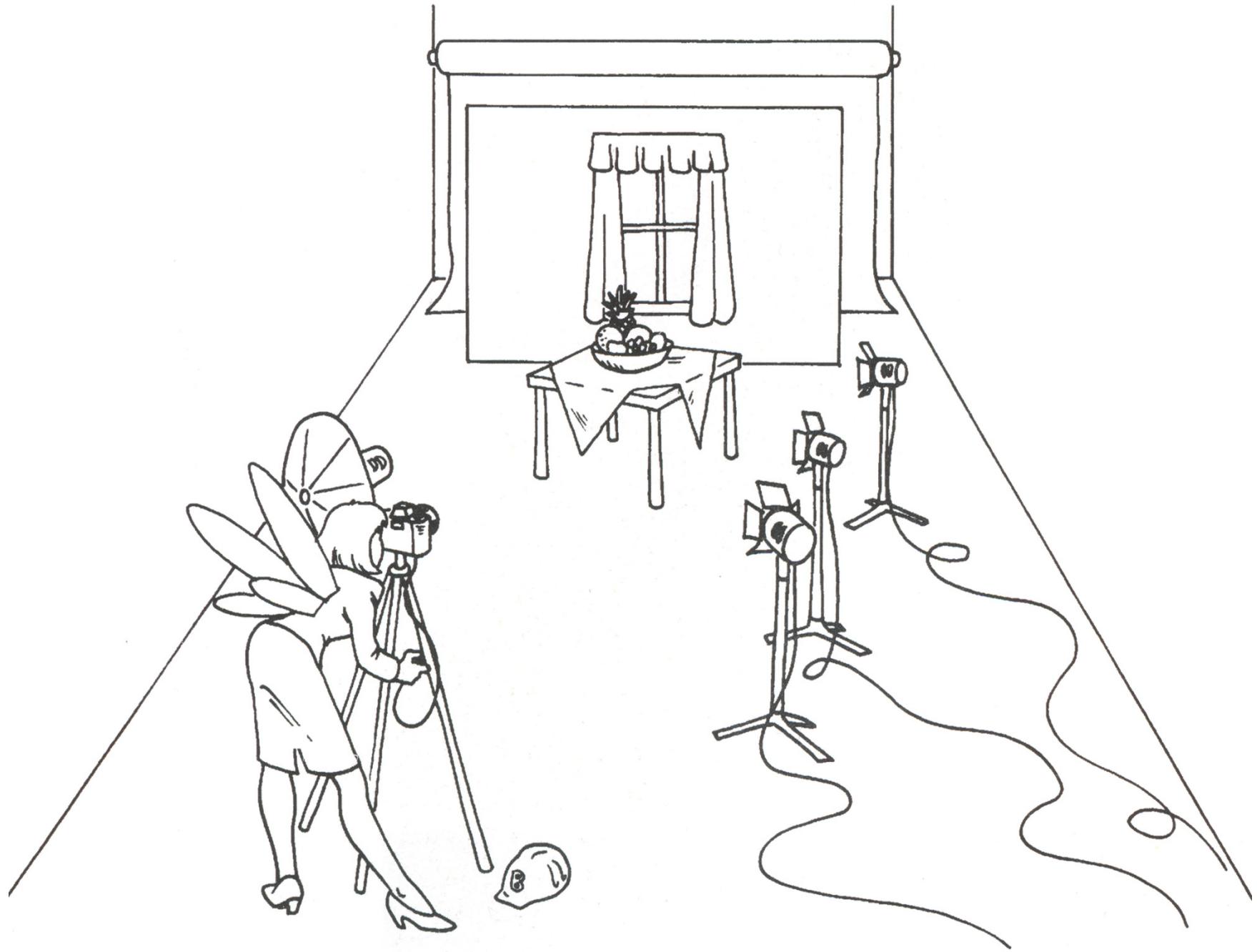


projekcije

perspektivne

enobežna
dvobežna
tribežna





GRAFIČNI CEVOVOD



grafični cevovod

geometrija

točke, ki določajo oglišča
povezave točk v večkotnike
lastnosti (barva, koordinate tekture,
normala)

teksture, luči, kamera, ...

sekvenčni vstop v cevovod
koordinatni sistem predmeta



grafični cevovod

prehod v koordinate pogleda



grafični cevovod

sprehod čez vse deklarirane luči
osvetlitev za vsako oglišče



grafični cevovod

prehod iz 3D koordinat v 2D



grafični cevovod

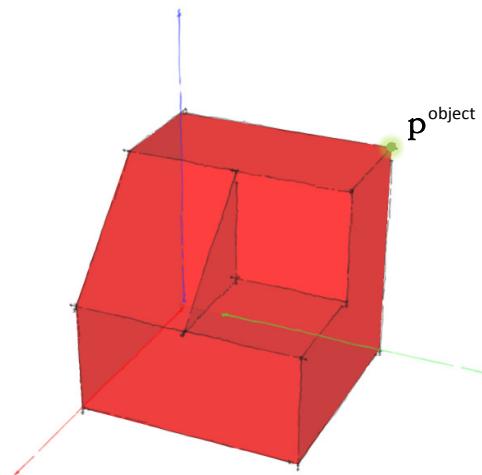
izris primitivov
ugotavljanje vidnosti



KOORDINATNI SISTEMI

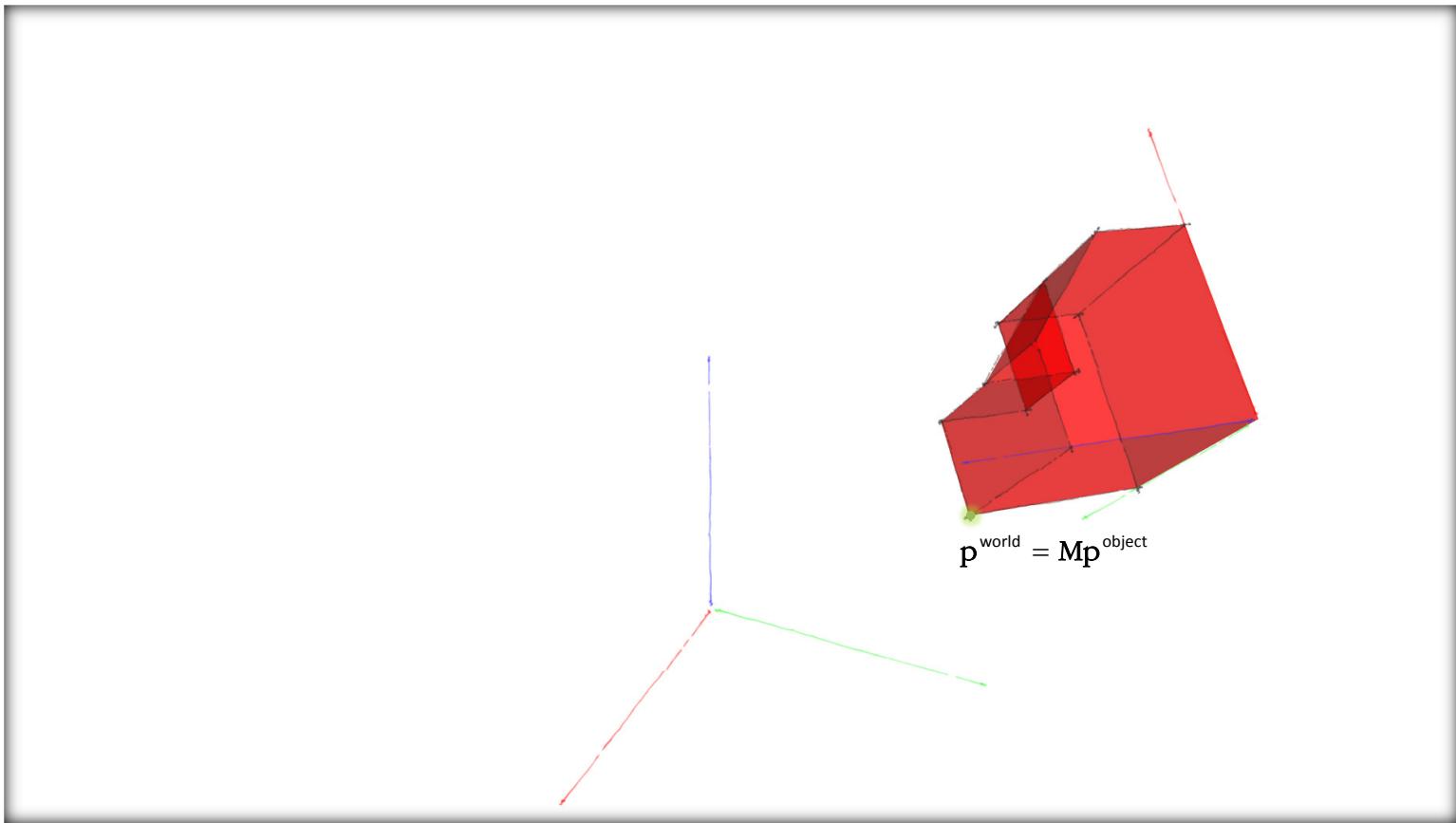
koordinatni sistemi

predmet



koordinatni sistemi

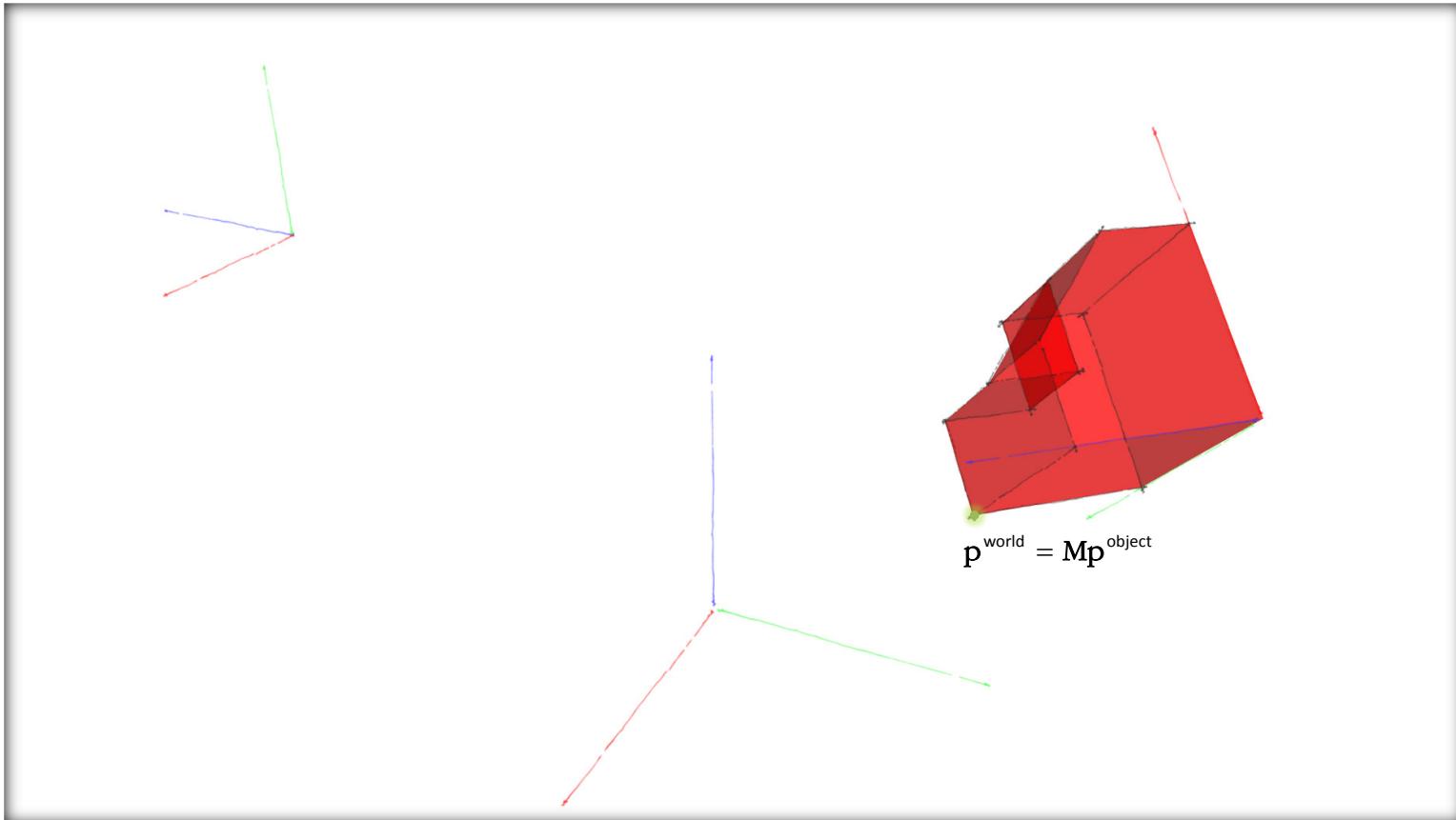
svet



predmet → svet **M**

koordinatni sistemi

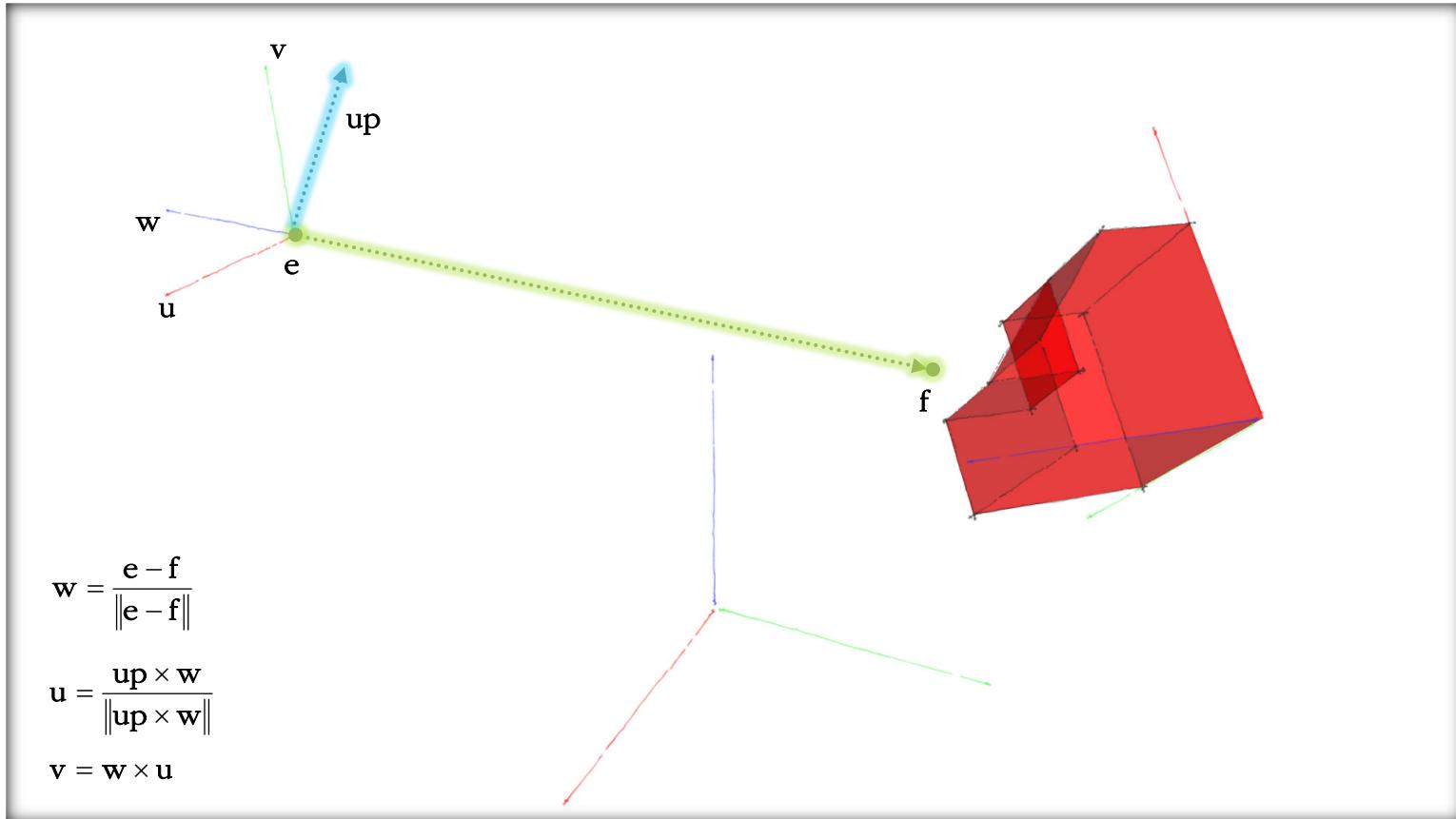
pogled



$$\text{pogled} \rightarrow \text{svet} \quad \mathbf{C} \quad \text{svet} \rightarrow \text{pogled} \quad \mathbf{C}^{-1} \quad \text{predmet} \rightarrow \text{pogled} \quad \mathbf{p}^{\text{camera}} = \mathbf{C}^{-1} \mathbf{M} \mathbf{p}^{\text{object}}$$

koordinatni sistemi

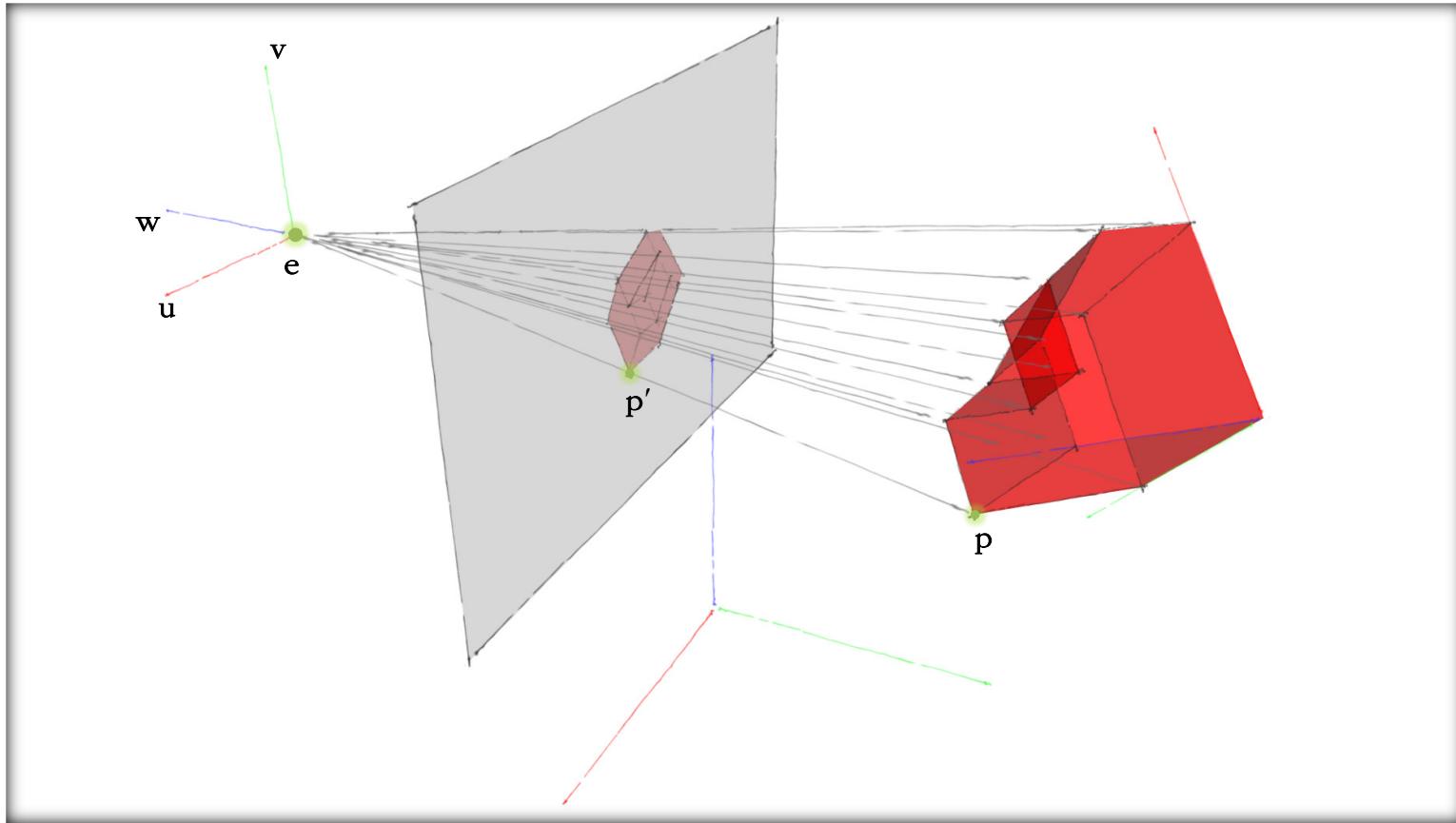
pogled



$$C = [u \quad v \quad w \quad e]$$

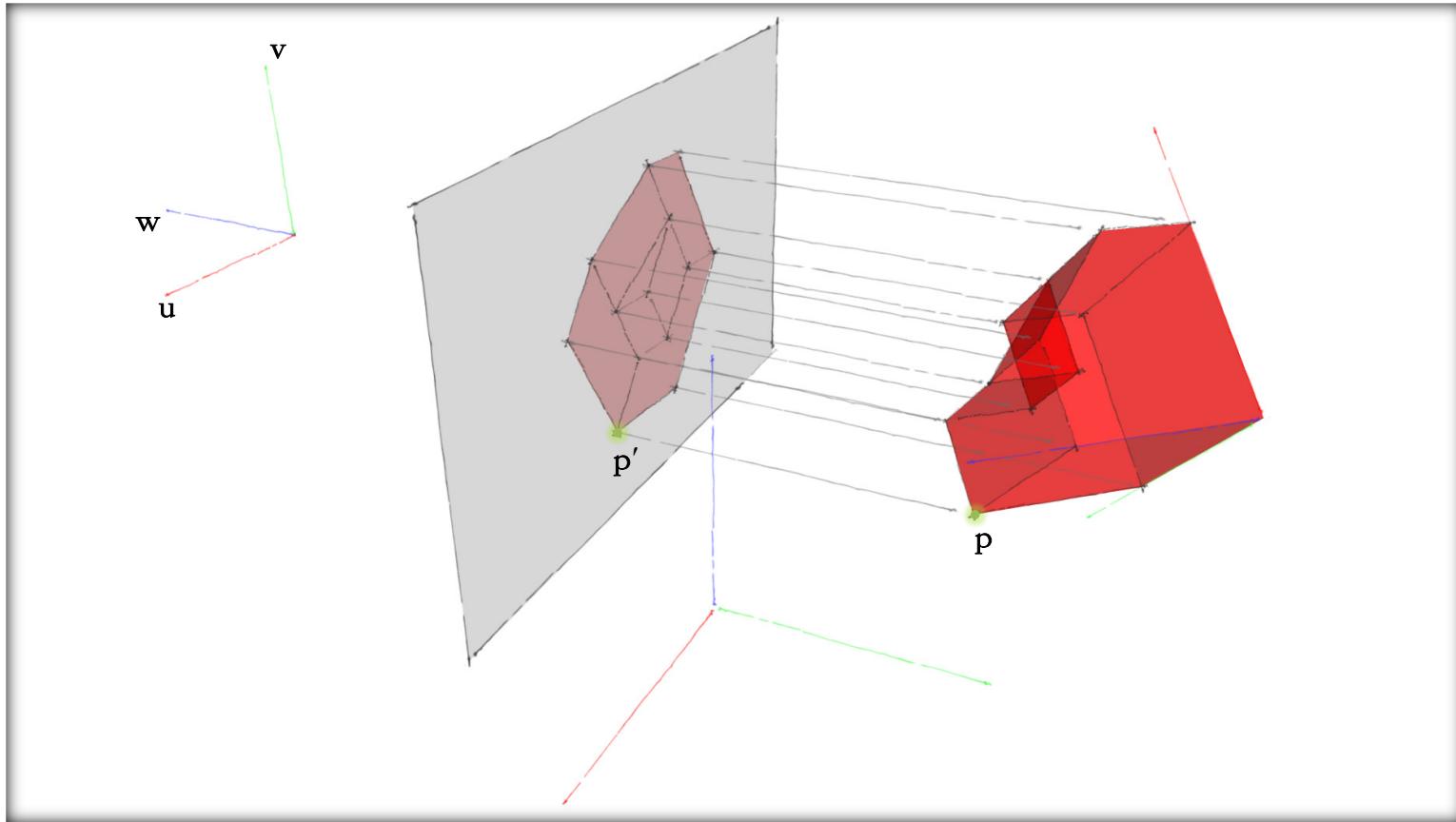
projekcija

perspektivna



projekcija

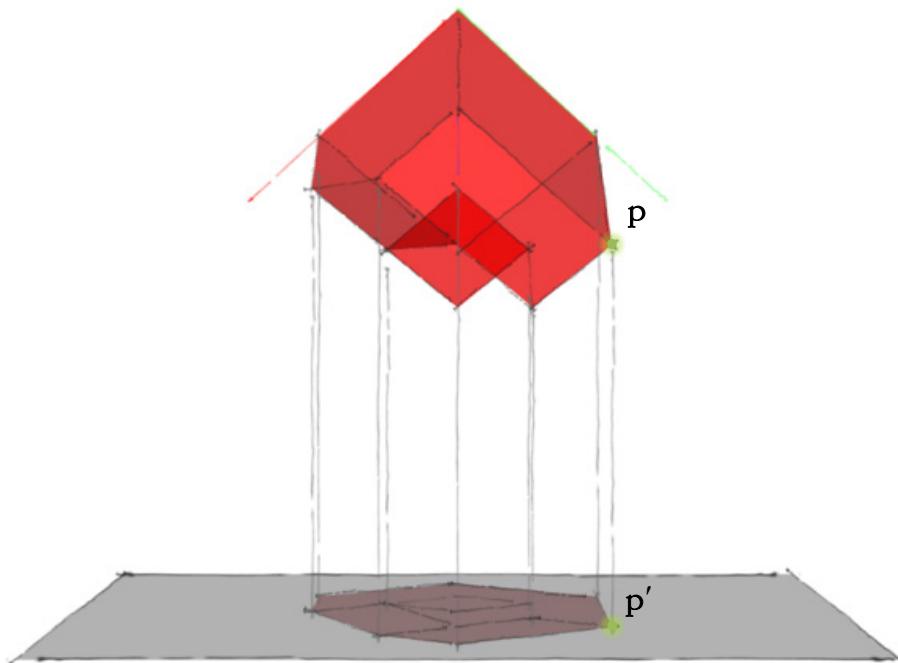
vzporedna



PROJEKCIJSKA TRANSFORMACIJA

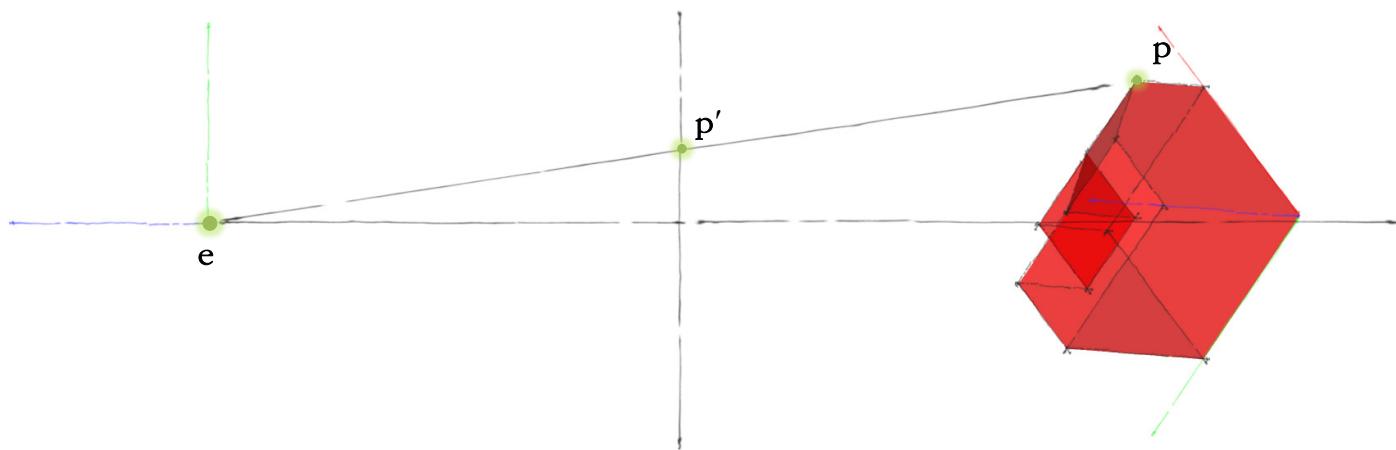
projekcijska transformacija

vzporedna pravokotna projekcija



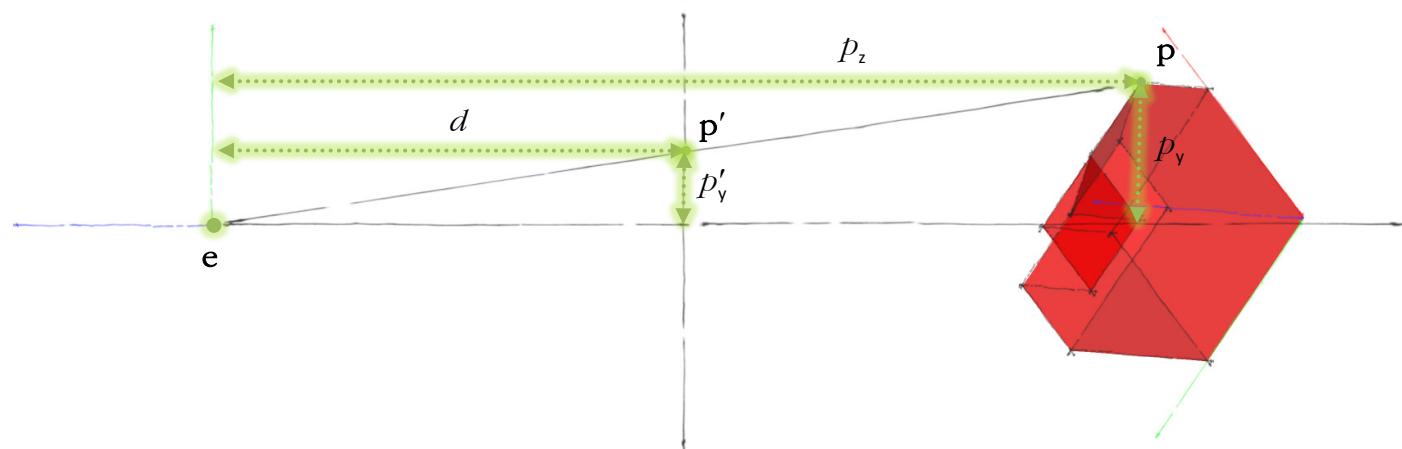
projekcijska transformacija

perspektivna projekcija
poenostavljen primer



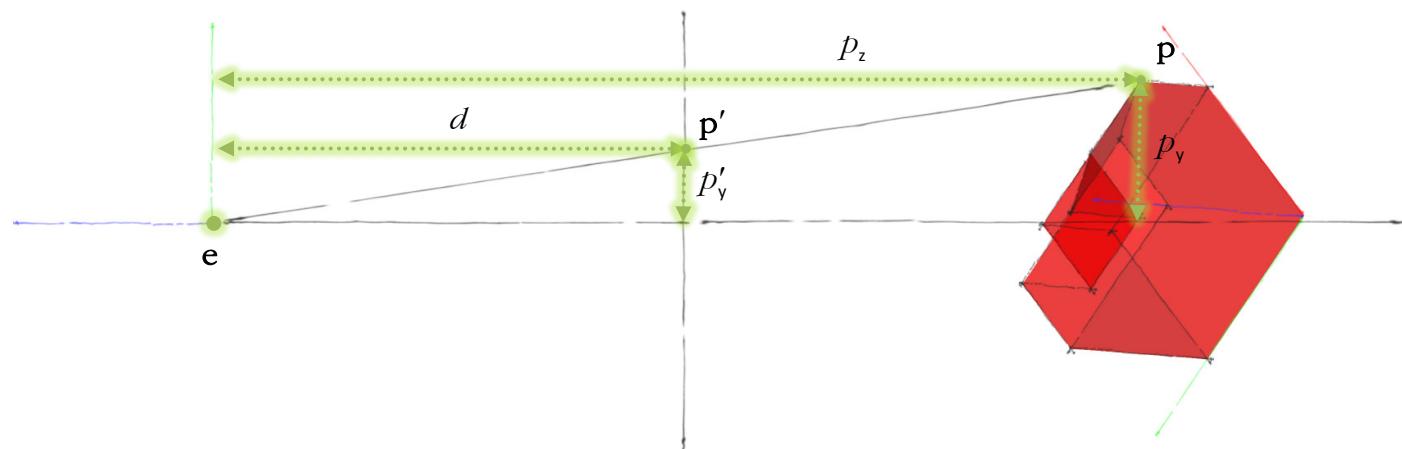
projekcijska transformacija

perspektivna projekcija
poenostavljen primer



projekcijska transformacija

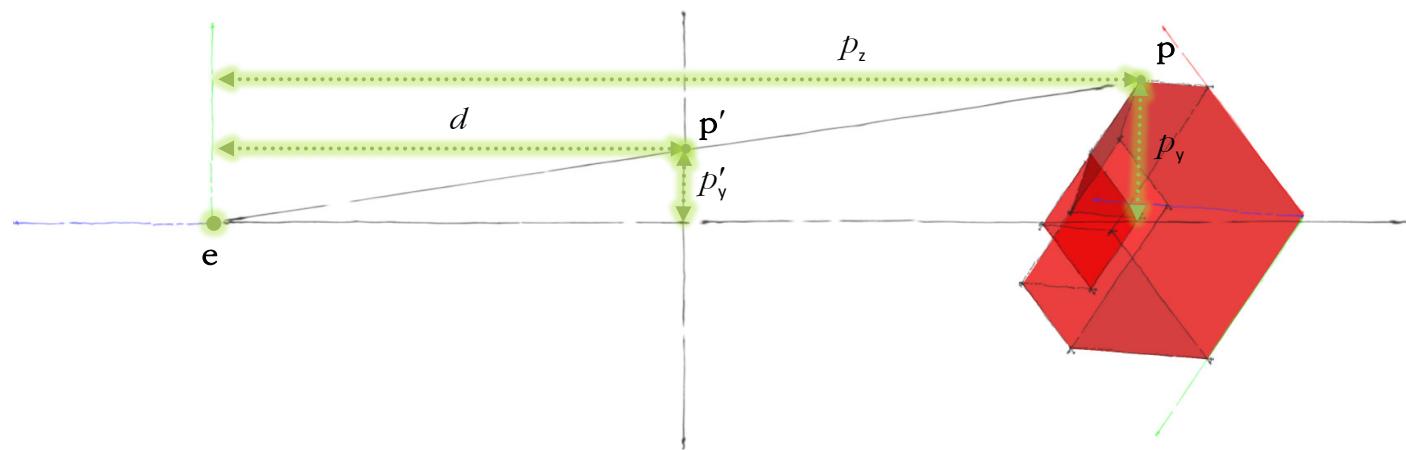
perspektivna projekcija
poenostavljen primer



$$\frac{p'_y}{d} = \frac{p_y}{p_z}, \quad \frac{p'_x}{d} = \frac{p_x}{p_z}$$

projekcijska transformacija

perspektivna projekcija
poenostavljen primer



$$p'_x = \frac{p_x d}{p_z}, \quad p'_y = \frac{p_y d}{p_z}, \quad p'_z = d$$

projekcijska transformacija

perspektivna projekcija
poenostavljen primer

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1/d & 0 \end{bmatrix} \begin{bmatrix} p_x \\ p_y \\ p_z \\ 1 \end{bmatrix} = \begin{bmatrix} p_x \\ p_y \\ p_z \\ p_z/d \end{bmatrix} \Rightarrow \begin{bmatrix} p_x d / p_z \\ p_y d / p_z \\ d \\ 1 \end{bmatrix}$$

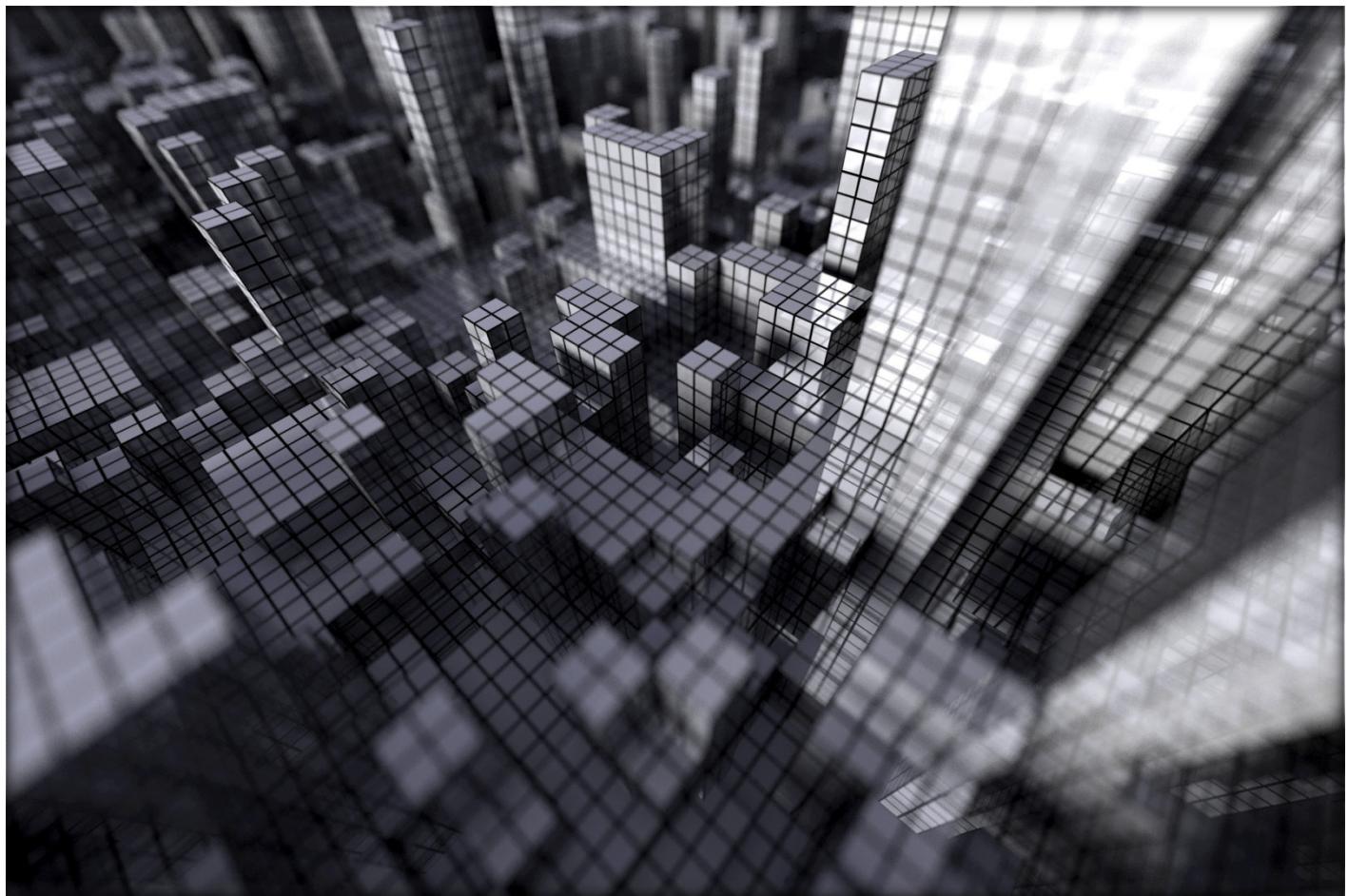
projekcijska transformacija

perspektivna projekcija
poenostavljen primer

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -1/d & 0 \end{bmatrix} \begin{bmatrix} p_x \\ p_y \\ p_z \\ 1 \end{bmatrix} = \begin{bmatrix} p_x \\ p_y \\ p_z \\ -p_z/d \end{bmatrix} \Rightarrow \begin{bmatrix} -p_x d / p_z \\ -p_y d / p_z \\ -d \\ 1 \end{bmatrix}$$

realizem

fokus in globinska ostrina



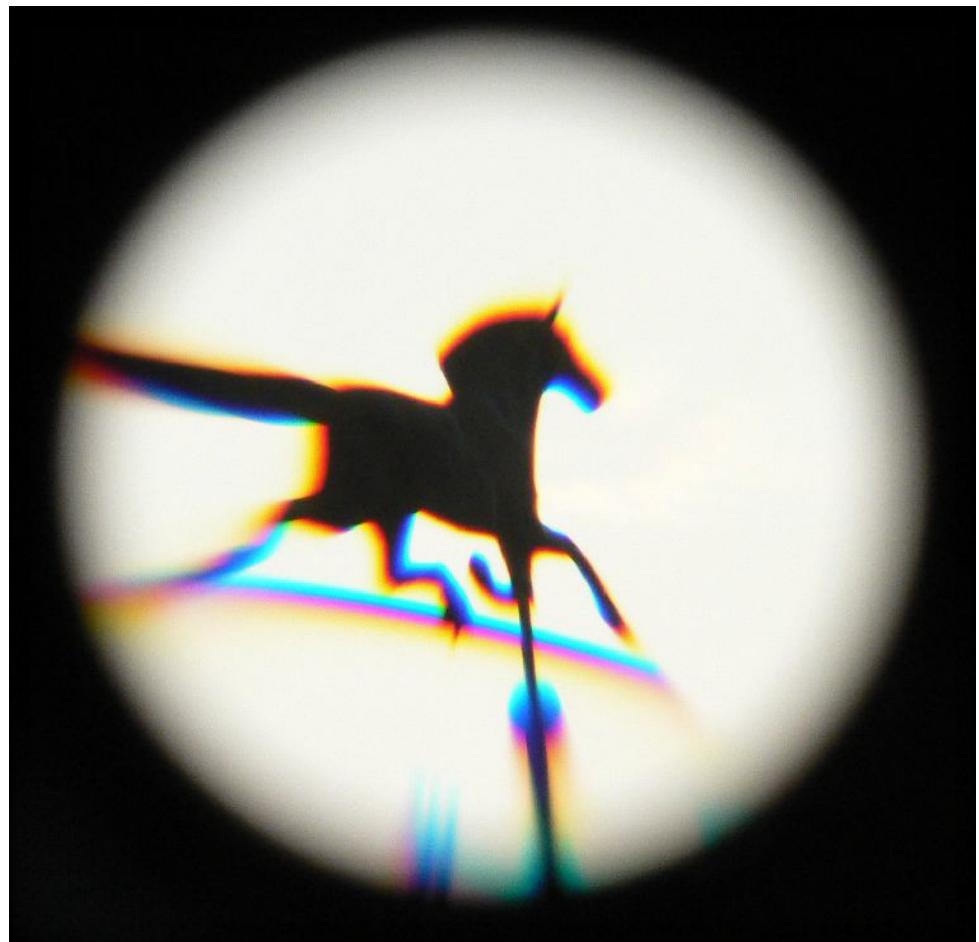
realizem

ribje oko



realizem

kromatska aberacija

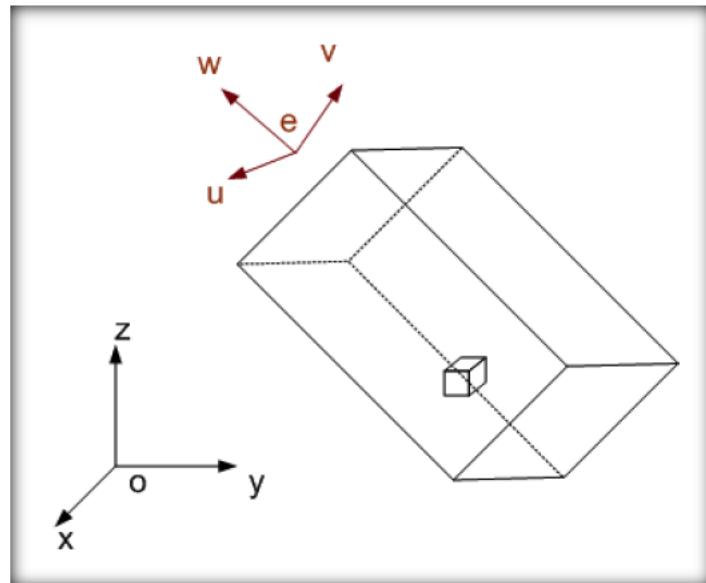
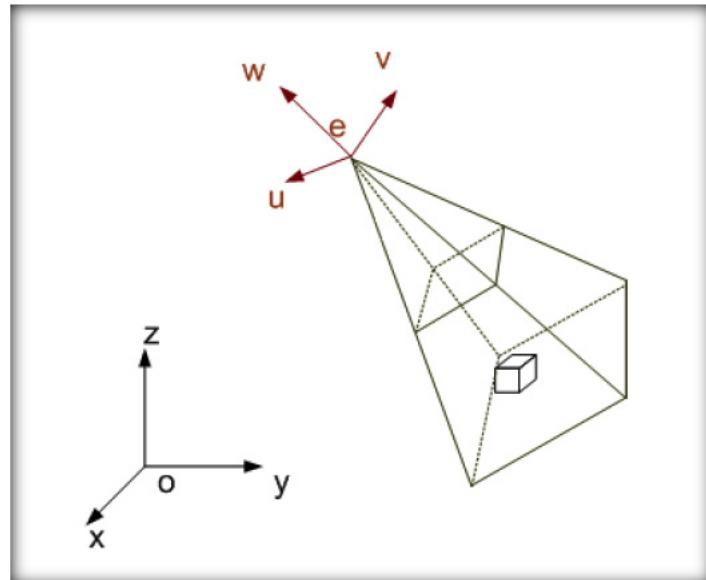


realizem

zaslonka

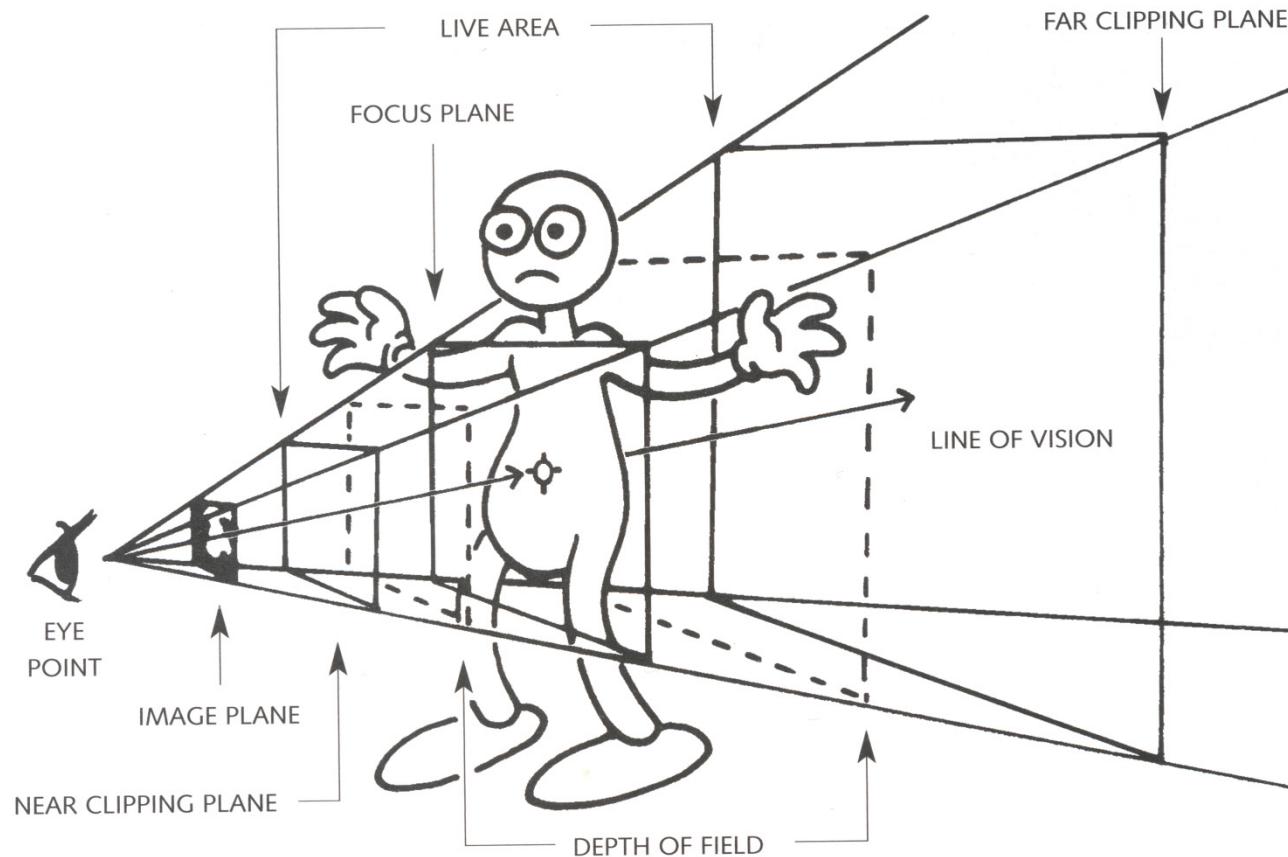


VIDNO POLJE



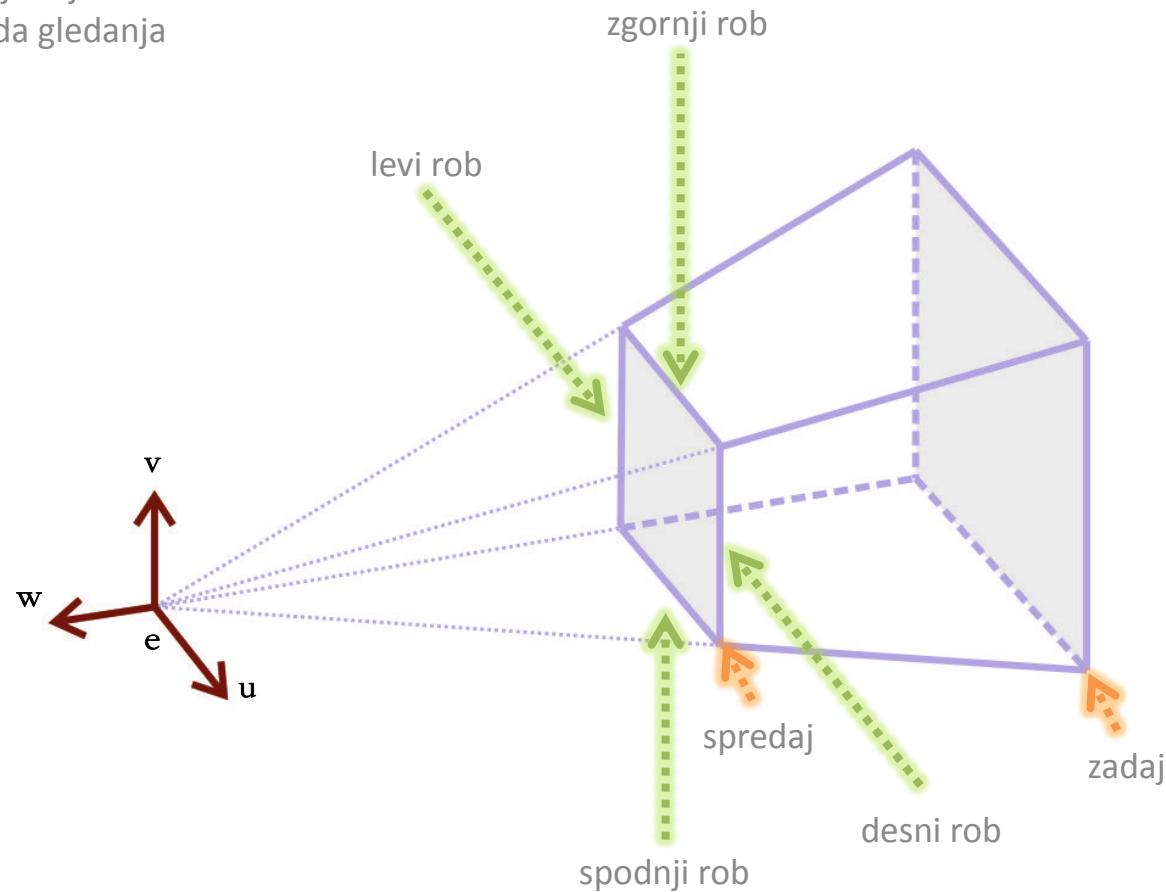
vidno polje

terminologija



vidno polje

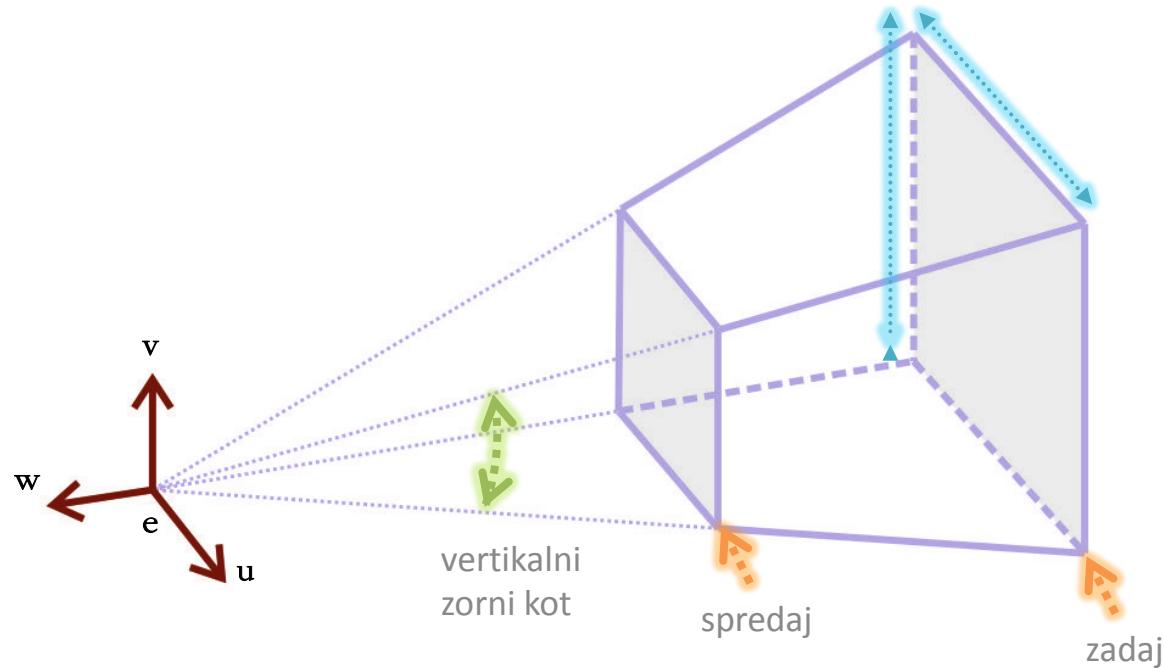
perspektivna projekcija
prirezana piramida gledanja



vidno polje

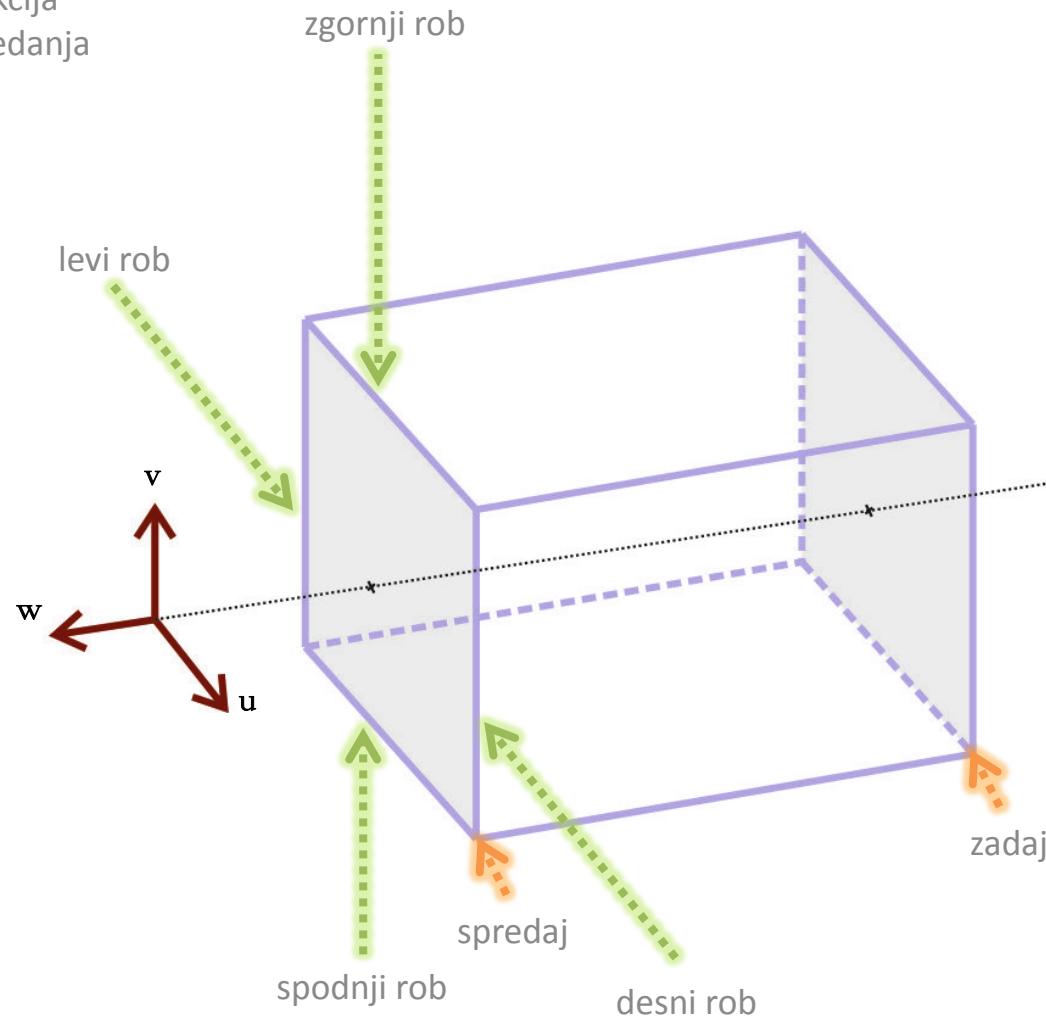
perspektivna projekcija
simetrična prirezana piramida gledanja

razmerje stranic
širina:višina



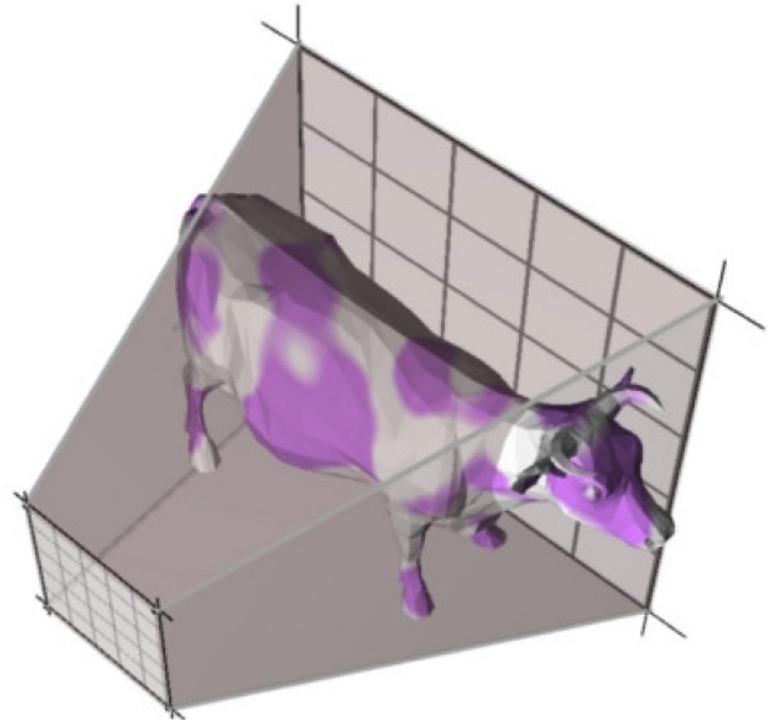
vidno polje

vzporedna projekcija
paralelepiped gledanja



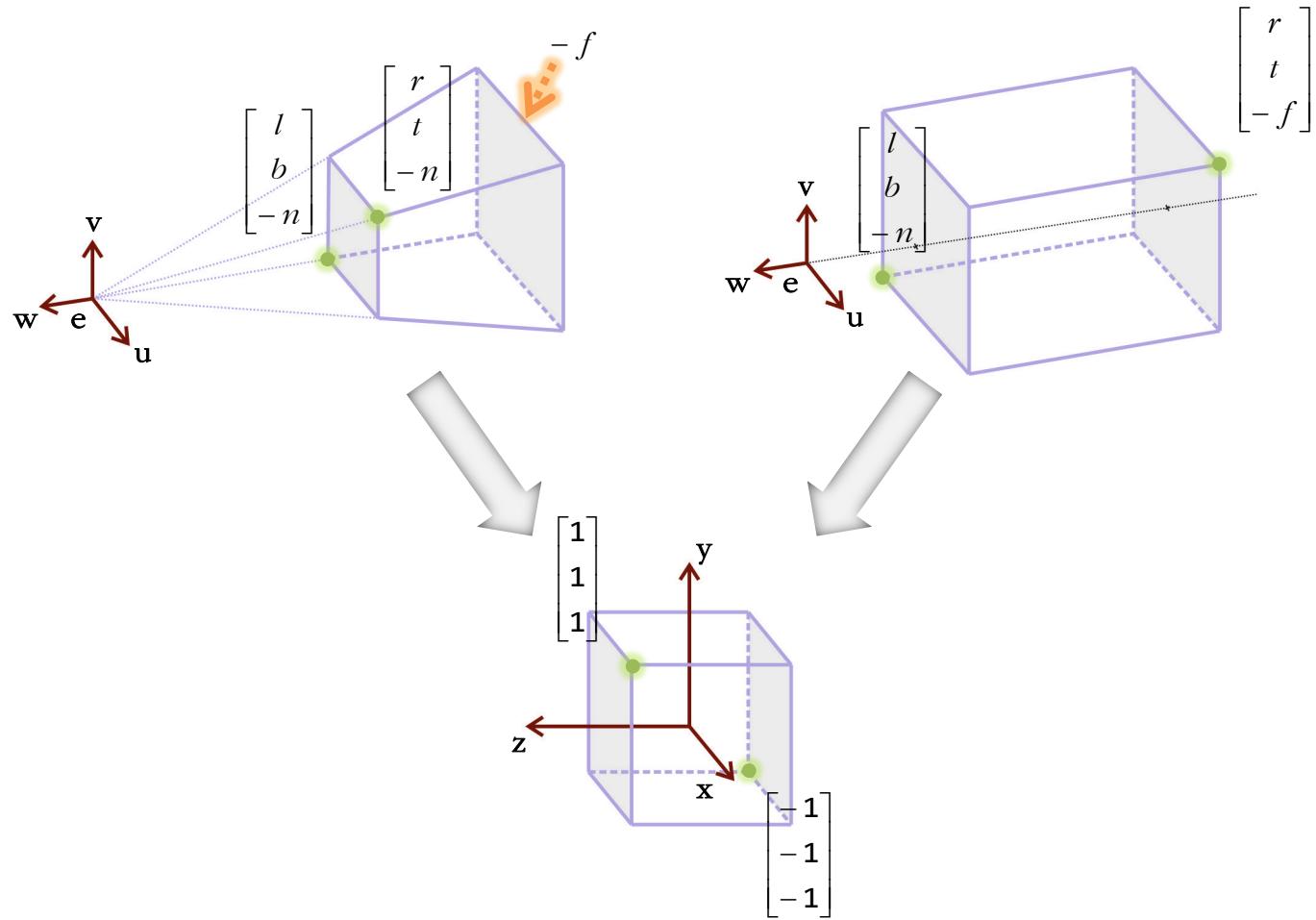
izločanje in

OBREZOVANJE



obrezovanje

normalizirane koordinate



PROJEKCIJSKA MATRIKA

projekcijska matrika

perspektivna projekcija
prirezana piramida gledanja

$$P_p(l, r, t, b, n, f) = \begin{bmatrix} \frac{2 * n}{r - l} & 0 & \frac{r + l}{r - l} & 0 \\ 0 & \frac{2 * n}{t - b} & \frac{t + b}{t - b} & 0 \\ 0 & 0 & -\frac{f + n}{f - n} & -\frac{2 * n * f}{f - n} \\ 0 & 0 & -1 & 0 \end{bmatrix}$$

projekcijska matrika

perspektivna projekcija

simetrična prerezana piramida gledanja

$$P_p(\alpha, a, n, f) = \begin{bmatrix} \frac{1}{a - \tan \frac{\alpha}{2}} & 0 & 0 & 0 \\ 0 & \frac{1}{\tan \frac{\alpha}{2}} & 0 & 0 \\ 0 & 0 & -\frac{f + n}{f - n} & -\frac{2 * n * f}{f - n} \\ 0 & 0 & -1 & 0 \end{bmatrix}$$

projekcijska matrika

pravokotna projekcija

$$P_o(l, r, t, b, n, f) = \begin{bmatrix} \frac{2}{r-l} & 0 & 0 & -\frac{r+l}{r-l} \\ 0 & \frac{2}{t-b} & 0 & -\frac{t+b}{t-b} \\ 0 & 0 & -\frac{2}{f-n} & -\frac{f+n}{f-n} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

projekcijska matrika

pravokotna projekcija
simetrična

$$P_o(w, b, n, f) = \begin{bmatrix} \frac{2}{w} & 0 & 0 & 0 \\ 0 & \frac{2}{b} & 0 & 0 \\ 0 & 0 & -\frac{2}{f-n} & -\frac{f+n}{f-n} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

projekcijska matrika

poševna projekcija

zamik sveta z uporabo striženja

pravokotna projekcija

$$P = P_o H(\theta, \varphi) = P_o \begin{bmatrix} 1 & 0 & \cot \theta & 0 \\ 0 & 1 & \cot \phi & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

matrika naprave

transformacija v koordinate naprave

$$D(x_0, x_1, y_0, y_1) = \begin{bmatrix} \frac{x_1 - x_0}{2} & 0 & 0 & \frac{x_0 + x_1}{2} \\ 0 & -\frac{y_1 - y_0}{2} & 0 & \frac{y_0 + y_1}{2} \\ 0 & 0 & \frac{1}{2} & \frac{1}{2} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

transformacijska veriga

matrika modela

matrika kamere

projekcijska matrika

matrika naprave

$$\mathbf{p}' = \mathbf{D} \mathbf{P} \mathbf{C}^{-1} \mathbf{M} \mathbf{p}$$

-
- The diagram illustrates the transformation chain with five vertical dashed lines of decreasing length from left to right, representing coordinate systems. A red dot at the bottom is labeled 'koordinatni sistem naprave'. Above it is a purple dot labeled 'normaliziran koordinatni sistem'. To its right is a blue dot labeled 'koordinatni sistem pogleda'. Further right is an orange dot labeled 'koordinatni sistem sveta'. At the top right is a green dot labeled 'koordinatni sistem predmeta'. The lines connect the dots sequentially from left to right, representing the transformation process.
- koordinatni sistem predmeta
 - koordinatni sistem sveta
 - koordinatni sistem pogleda
 - normaliziran koordinatni sistem
 - koordinatni sistem naprave

transformacijska veriga

matrika modela

matrika kamere

projekcijska matrika

matrika naprave

$$\mathbf{p}' = \begin{bmatrix} p'_x \\ p'_y \\ p'_z \\ w' \end{bmatrix}$$


$p'_x/w', \ p'_y/w'$
slikovni element

transformirana točka

projekcija

projekcije
vzporedne, perspektivne, taksonomija

grafični cevovod
*transformacija modela in pogleda, izračun osvetlitve, projekcija,
rasterizacija in prekrivanje*

koordinatni sistemi
predmeta, sveta, pogleda, naprave

parametri kamere
očišče, koordinatni sistem pogleda, projekcijska ravnina

vidno polje
perspektivna projekcija, vzporedna projekcija

projekcijska matrika
*perspektivna projekcija, vzporedna projekcija,
normalizirane koordinate, transformacijska veriga*

<http://www.cs.mtsu.edu/~jhankins/pages/planerview3D.html>

http://metal.brightcookie.com/2_draw/draw_t3/htm/draw3_2.htm

Baker, *Computer Graphics with OpenGL*, 3rd ed, **ch 6,7**

Angel, *Interactive Computer Graphics*, 5th Ed., **ch 1.4-6,5**

Akenine-Möller, Haines, Hoffman, *Real-Time Rendering*, 3rd Ed., **ch 2,4,6**

Lengyel, *Mathematics for 3D Game Programming & Computer Graphics*, **ch 4.3,4.5**

Dunn, Parberry, *3D Math Primer for Graphics and Game Development*, **ch 3,9,4**

Eberly, *3D Game Engine Design*, **ch 3.1-4**

Guid, *Računalniška grafika*, **ch 5,6**

dodatna literatura

DO PRIHODNJIČ