Creating a orthonormal coordinate frame

Let a be the viewing direction $eye - center$ and let b be the up vector. Assume the camera is centered at the origin.

$w = \frac{a}{|a|}$
$u = \frac{b \times w}{|b \times w|}$
$v = w \times u$

Creating a ray from the camera

Let $width, height$ be the screen resolution.

We want to create a ray through the virtual screen, given the w vector and a pixel postion given by i, j.

Let α be the screen intersection in the u direction on $[-1, 1]$ and β be the screen intersection in the v direction on $[-1, 1]$.

Therefore
$\alpha = tan\left(\frac{fovx}{2}\right) \times \left(\frac{j-(width/2)}{width/2}\right)$
$\beta = tan\left(\frac{fovy}{2}\right) \times \left(\frac{(height/2)-i}{height/2}\right)$

With
$aspect = \frac{width}{height}$
$fovx = 2 * atan\left(tan\left(\frac{fovy}{2}\right) * aspect\right)$

And
$ray = eye + \frac{\alpha u + \beta v - w}{|\alpha u + \beta v - w|}$