Description

Hotkey

Through `glfwSetKeyCallback`, I make that program interactable. In detail, the program can respond to those hotkeys.

hotkey	description
`N`	shift between right and wrong normals. (yellow is wrong, pink is right)
`SPACE`	play or pause the animation.
`q`	quit

Normal Object Drawing

Since we have the origin normal vector T for each vertex P of the torus. So the normal line PQ can be defined with 2 points P and $Q = P + sT$, where s is the scale that determine the length of the line.

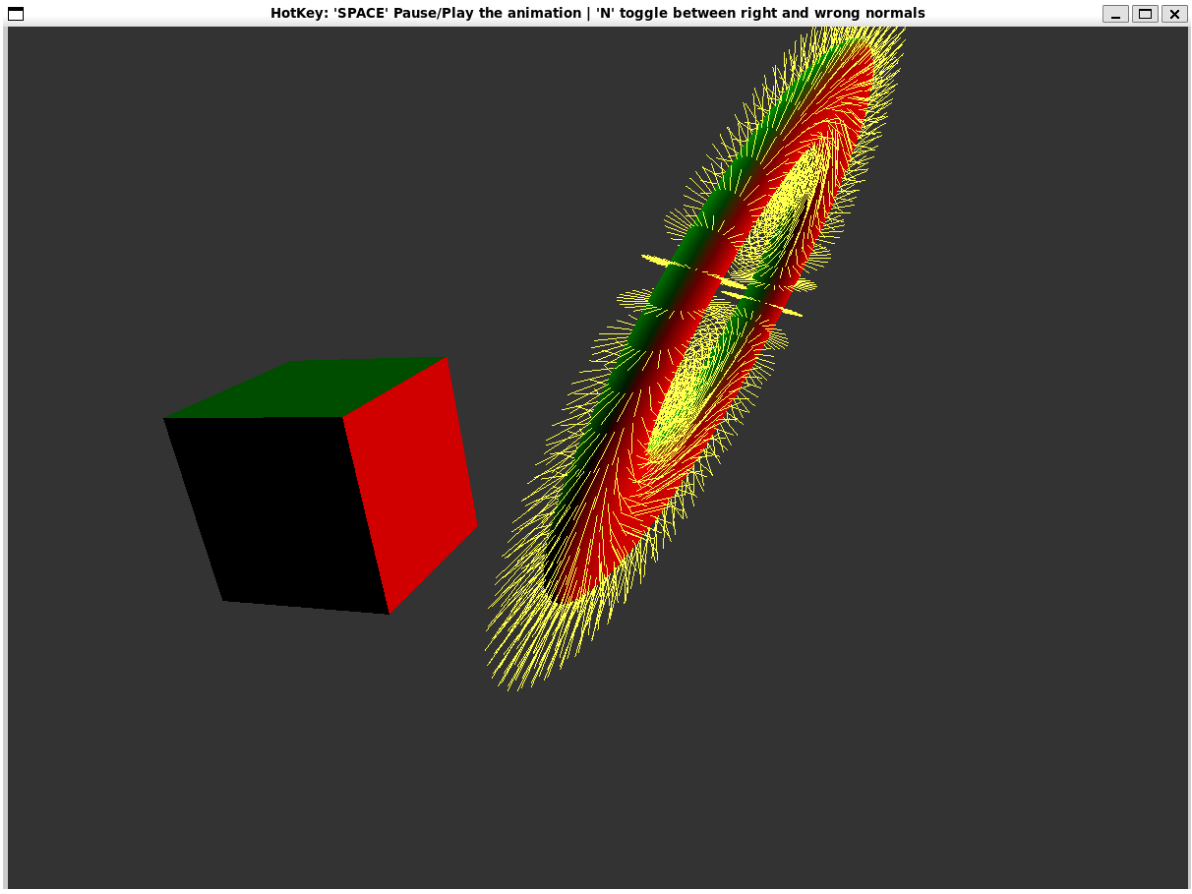
When the torus are transformed by multiply a model view matrix M, we get a new $P' = MP$ and $Q' = MP + sMT$, if the upper left subpart of M are not orthogonal (e.g. scale is applied), the perpendicularity between $P'Q'$ and the torus surface are not exist anymore. The new normal vector should be $T' = NT = (M^{-1})^T T$, where N is what we call normal matrix. So we should shift the wrong endpoint Q' to the right one $Q'_N = P' + T' = MP + NT$.

In implementation, we should firstly calculate the right endpoint of the normal line and pass it to the VAO, then in the shader program, we apply the model view transform to each vertex, Q'_N is no exception. But as we can see, the normal matrix N is dependent with the model view matrix M. So we should update the position of the endpoint whenever the M changes, and multiply the inverse of M in advance before it changed by the shader.

- $Q_{temp} = P + M^{-1}NT$ (see detail in MultiLine::updateNormalDisplay)
- $Q'_N = MQ_{temp} = MP + NT$ (see detail in Normals.vert)

Result

Wrong normal



Right normal