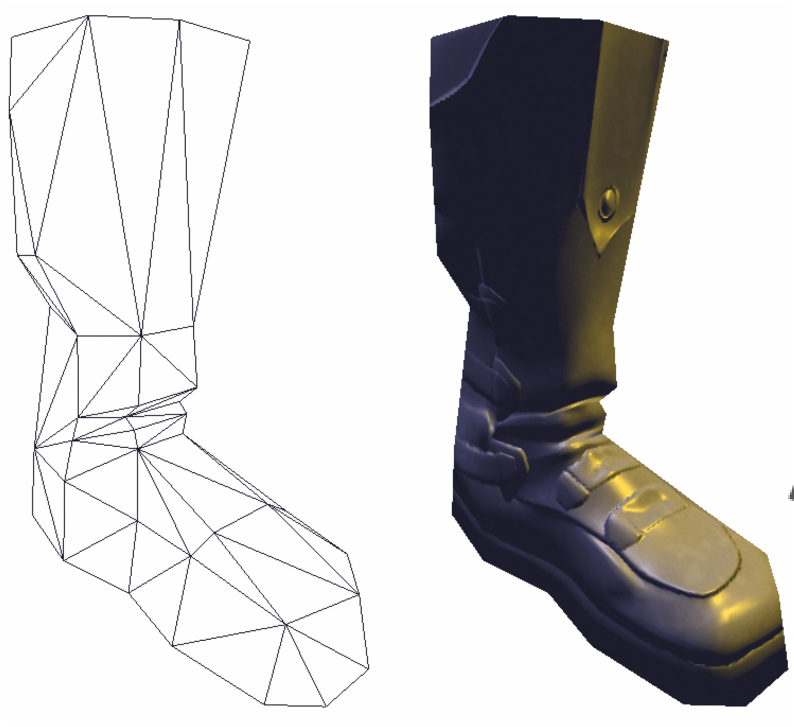
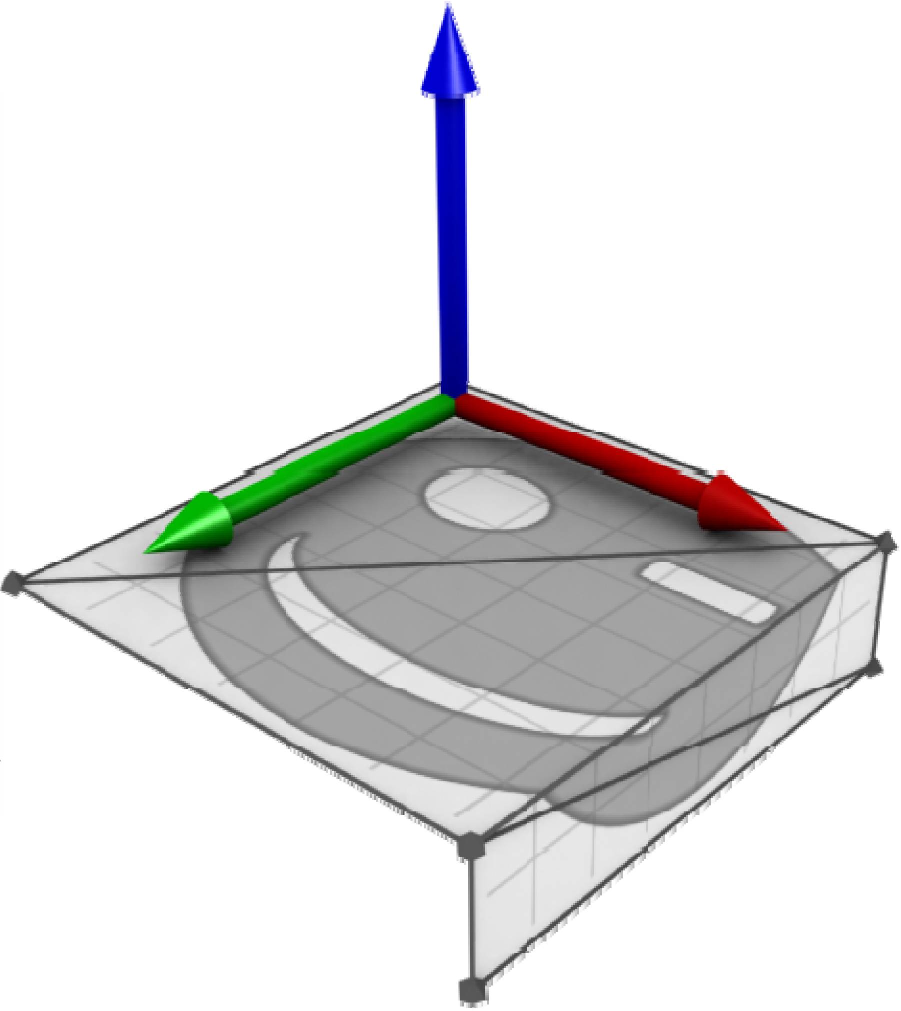
Triangle mesh tangent space calculation

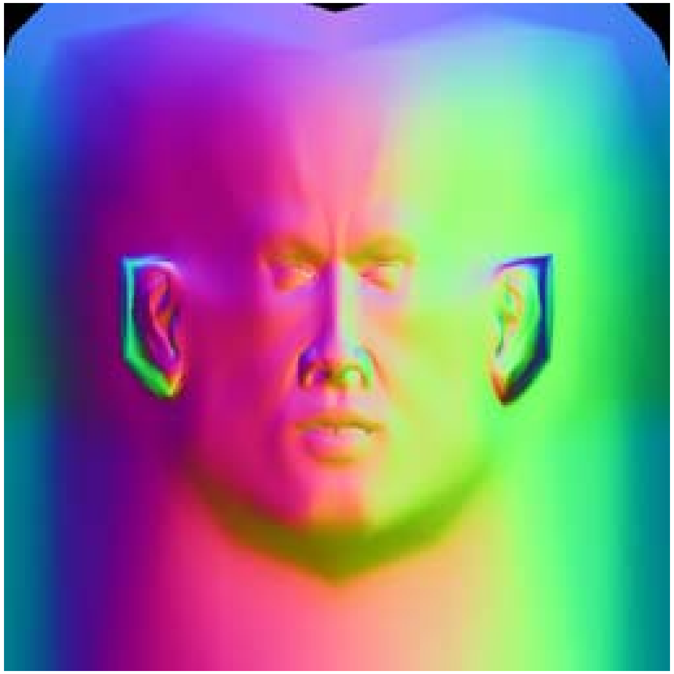




Martin Mittring

Object space normal maps

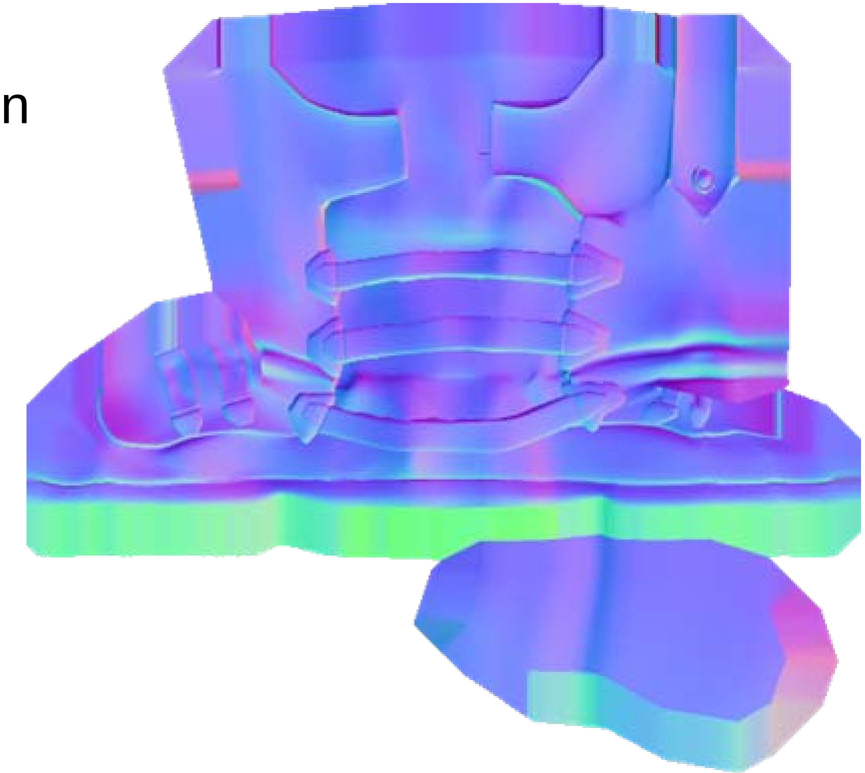
- 3d vector encoded as colour (colourful)
- Simple math
- Reuse limited to translation / scale and per object mirror / Rotate



Tangent space normal maps

- 3d vector encoded as colour (blueish)
- Relative to the surface (in tangent space)
- Reuse:
  Arbitrary
- Texture compression
- Hard to avoid artefacts and seams

-> good tangent space calculation helps



tangent space is a useful mathematical tool

- (tangent,binormal,normal) = 3x3 matrix
- Computations in tangent space can be more efficient (cheaper pixel shader)
- Storing data in tangent space decouples the data from its local surface orientation which allows arbitraty reuse and efficient storage
- Applications: normal maps, horizon maps, POM , PTM, …

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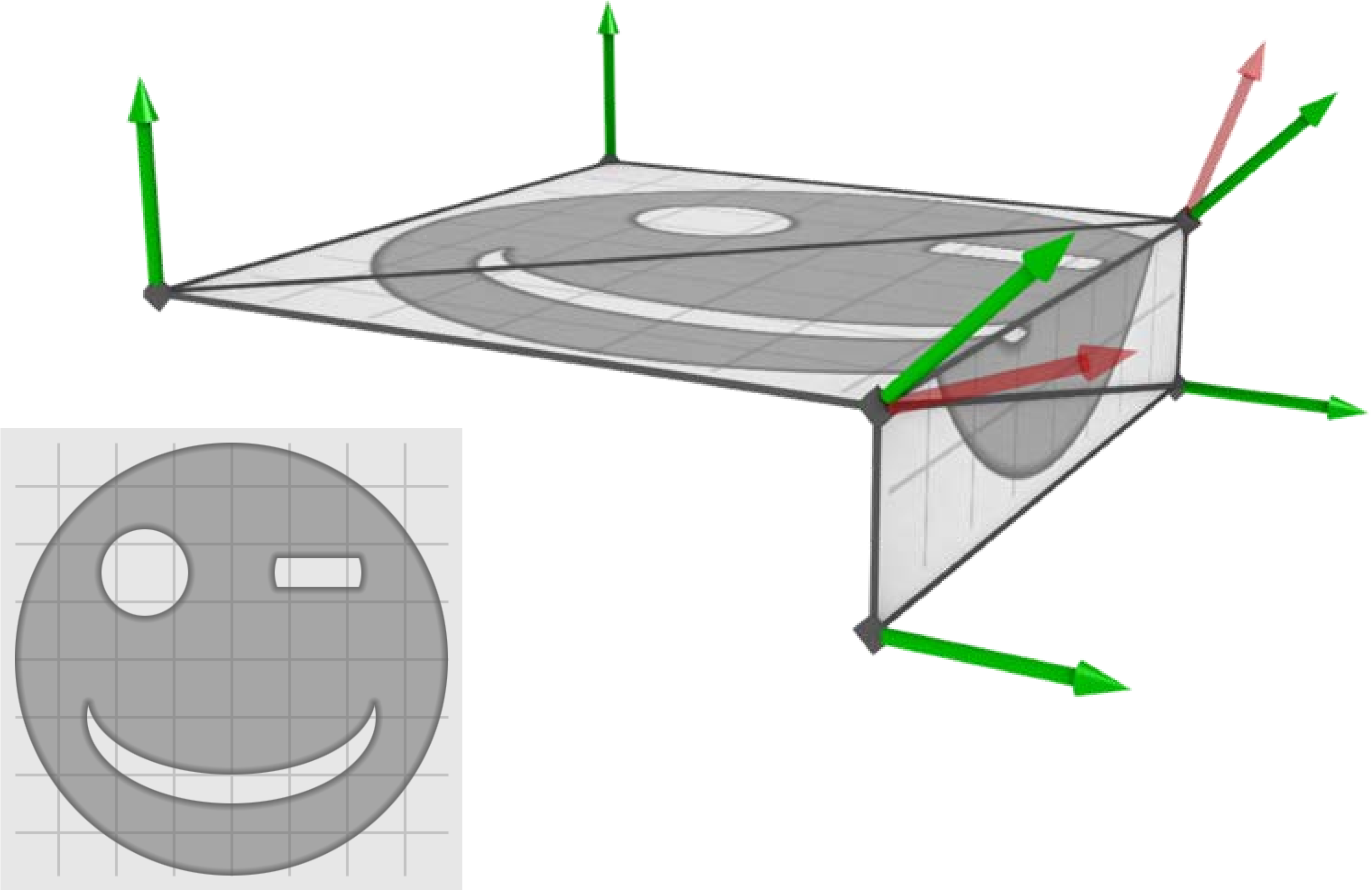
Requirements

- Easy to integrate (source, 3dsmax/maya)
- Efficient
- No magic
- Support for mirroring
- Minimal vertex splits
- Tiling textures
- Documented
- Tested and proven
- Tesselation independent result (L Shape)

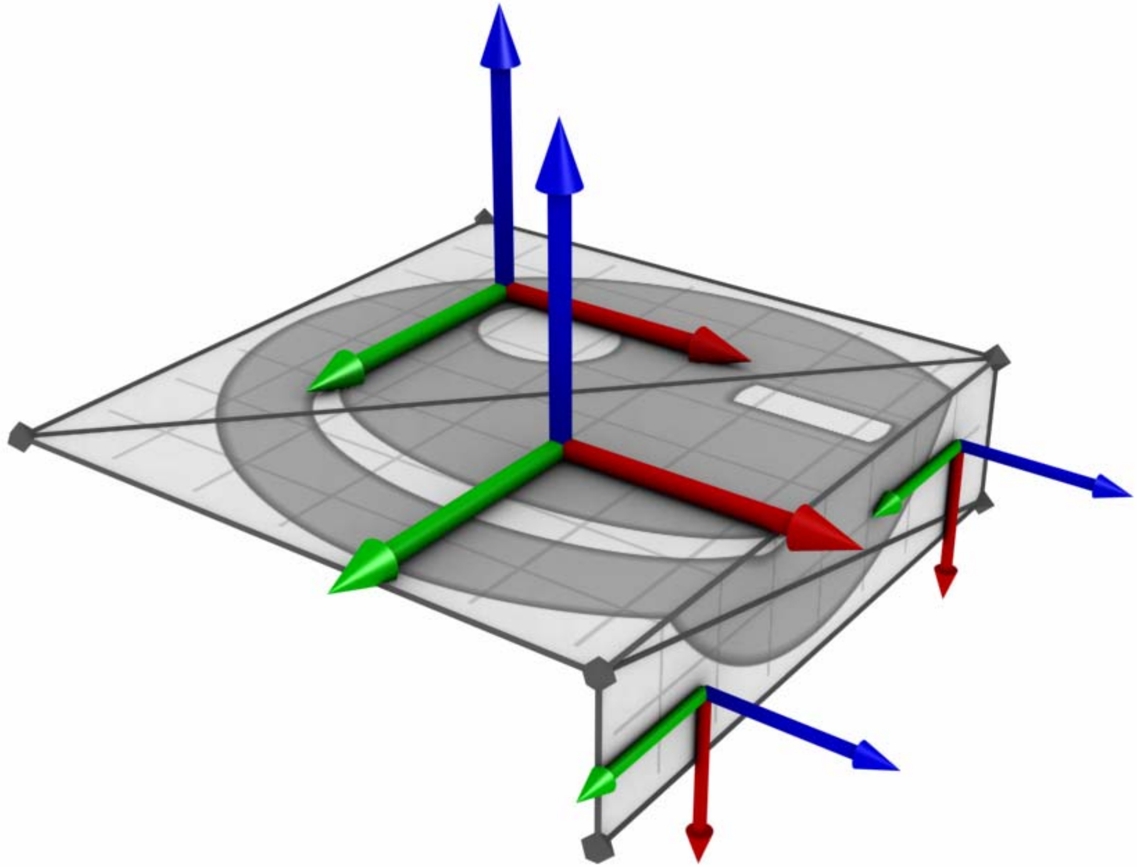
L shape problem



Step 1/3: TS per triangle

- Compute 3x3 matrix that transforms 3 given points in UV space to 3 points in world space – ignoring the translation
- Weight by the UV triangle size to avoid domination of small triangles

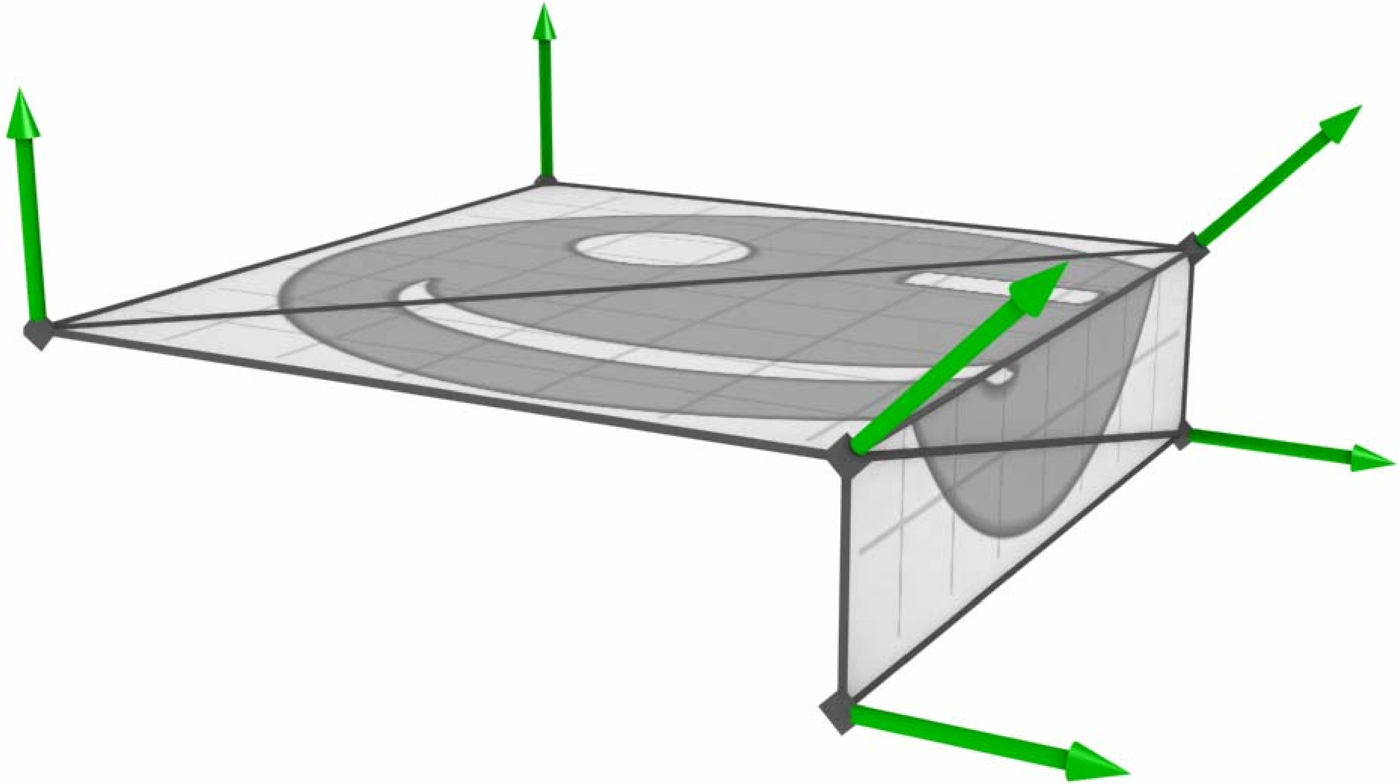
Tangent space per triangle



Step 2/3: Normal per vertex

- Accumulate neighbour triangle normals per vertex
(if edge [between vertex triangle and neighbour triangle] is smooth)
- Weighted by angle to get tesselation independent result (L shape problem)

Normal per vertex



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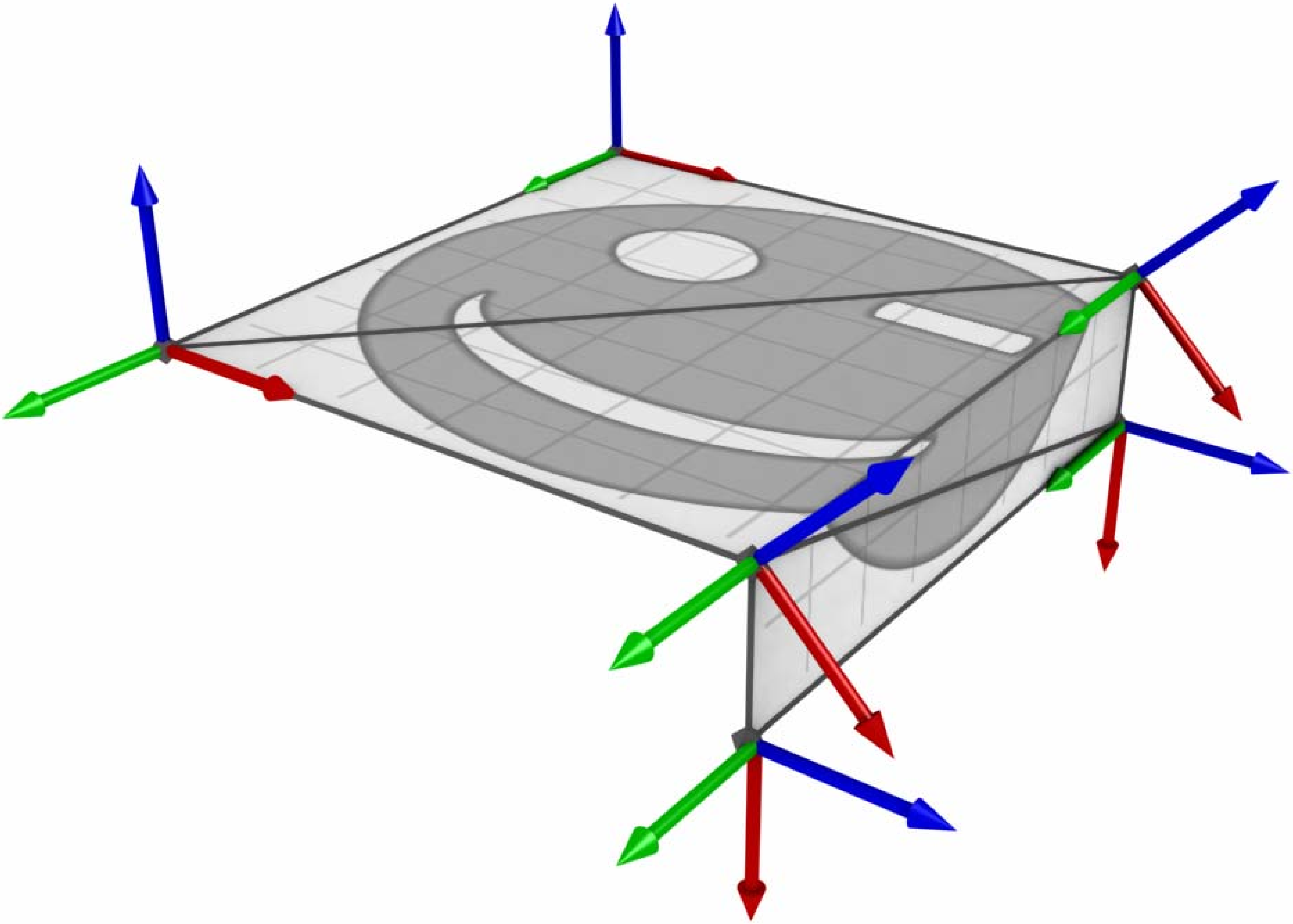
Step 3/3: TS per vertex

- Accumulate neighbour triangle u and v per vertex
  (if edge [between vertex triangle and neighbour triangle] is smooth)
- Split vertices in case of mirroring (matrix party) or heavy rotations (90 degree)
- Weighted by angle to get tesselation independent result (L shape problem)

TS per vertex

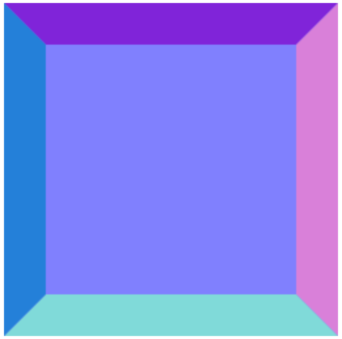


Compressing
the tangent space matrix

- Normalize u and v
- Store u and v in 8 or 16bit per component
- n = normalize(cross(u,v)) * k
- k = {-1;1} is required for mirroring
- Storing n and reconstructing u or v does not cope well with shearing

Tips to get best quality

- The same TS computation everywhere
- Store T or T^{-1}
- Artist can hide seams
- Reorthogonalize? [Engel05]
- Avoid shearing in the input data
- Check with reference tangent space texture
- Do shading in world space
- Decoding with *2-1 doesn‘t support (0,0,1), *128/255-1 does



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Triangle mesh tangent space calculation

- Thanks to Ivo Herzeg and Crytek
- Free source can be found in
  the free Farcry MOD SDK
- Source and more details can be found in ShaderX4 book [Engel05]

References:

- [Engel05] Martin Mittring, “Triangle Mesh Tangent Space Calculation“ in ShaderX4 pages 77-89