PA213

Marek Trtík

NURBS Assignment

HCI LAB VISITlab

Assignment

- The goal of the assignment is to provide rendering of NURBS surfaces.

  => We must implement NURBS-related algorithms.

  [We assume actual rendering of obtained meshes is available.]

- We basically need this functionality:
  - Computation of points on the surface. [To represent the surface by a triangle mesh]
  - Computation of both partial derivatives at each point. [To compute normals for lighting]

Implementation

- Your **entire implementation** will be inside file:

  nurbs.cpp

- All **Core functions** in the file must be implemented.
  - Current implementations are **not** correct.
- The *Utility functions* are already implemented; please, do *not* change them.
- The main source of know-how are the lecture slides and also these slides.
  - Slides marked by “HOMEWORK HELP” are the most relevant.
  - If you do not understand something, then **contact teachers**!
- Each function has a comment in the **nurbs.cpp** file describing its purpose.
  - Under *IMPLMENTATION* comment there are requirements, hints, and links to slides.

Implementation

- Your algorithms will work with a **polynomial** surface defined in the **homogeneous space**. So, all these data are provided by the application:
  - The grid of control points $\mathbf{P}_{i,j}^{w}$ of the surface in the homogeneous space.
  - The degree (p, q) of the surface.
  - Nonperiodic and uniform knot vectors U and V of the basis functions.
- **find_span** and **evaluate_basis_functions** must have highly efficient implementation.
- It is recommended to implement the functions in top-down order in the file.

Testing and submission

- There are tests in the assignment.
  - You can run them via a button in application's menu.
  - Results from their execution can be found in the console.
  - Make sure all tests are passing before submitting results to IS.
- It is sufficient to submit just the file **nurbs.cpp** to IS.
- IMPORTANT: When in troubles, contact teachers!
  - Send us an email; describe the issue; attach your nurbs.cpp file to the email.

Hints

Computation of points on a curve and surface

- Computation of a point on a B-spline curve in the homogeneous space, a.k.a. **point_on_curve_in_homogeneous_space**:

$$\mathbf{C}^w(t) = \sum_{i=0}^{n} N_{i,p}(t)\mathbf{P}_i^w$$

At most $p + 1$ of the functions may be non-zero.

- Computation of a point on a B-spline curve in the homogeneous space, a.k.a. **point_on_surface_in_homogeneous_space** (the first one):

$$\mathbf{S}^w(u,v) = \sum_{i=0}^{m} N_{i,p}(u)\left(\sum_{j=0}^{n} N_{j,q}(v)\mathbf{P}_{i,j}^w\right)$$

At most $p + 1$ of the functions may be non-zero.

Call **point_on_curve_in_homogeneous_space** `to get the point.`