Lecture0 Introduction

1. Introduction

Welcome to CZ2003 Computer Graphics and Visualization.

Lectures will be conducted in real class as revisions of the TEL lectures and hands-on exercises. The lecture slides as well as the TEL video lectures are published in the ***Content/Lectures*** folder of the course-site.

Textbook is available for free downloading from the NTU library. Refer to ***Content/Textbook*** folder of the course-site.

Tutorials will start on teaching week #2 as usual in tutorial rooms. The tutorial questions can be downloaded from *Content/Tutorials* folder of the course-site. For each of 12 tutorials, you have to prepare written solutions, in a way how you do it during the exams, and **email them in PDF file** to your tutors **before each tutorial**. **Late submissions will be rejected.** Each tutorial solution will be marked and emailed back to you. The tutorial component will contribute **10%** to the final mark for the course.
Tutorial groups instructors:

- Alexei Sourin (assourin@ntu.edu.sg): SCSE1 ✓
- Zheng Jianmin (asjmzheng@ntu.edu.sg): SCSE2

Labs will start on week 3 and will have 5 experiments. You can work on your lab assignments both in one of the allocated SW Labs or on your personal computers while keeping online contact with your lab instructor. Refer to the *Content/Labs* folder of the course-site for the lab manual, software tools to install, templates of the codes and the lab report. Each of the five assignments has to be submitted through the ***Assignments*** digital drop box in the course-site **one week after the end of each respective lab session**, as it is scheduled in your lab schedule. **Late submissions will be rejected.** One~two weeks after the submission, you will know your awarded points through the course-site. The lab component will contribute **50%** to the final mark for the course, i.e. each lab can earn you up to **12**%. Lab consultations and assessment will be performed according to your official allocation to the lab groups as follows:

- Alexei Sourin: SCSE1 ✓
- Zheng Jianmin: SCSE2

Final examination will cotribute 40% to the final mark.

Consultations/questions: Through the Discussion Board if the questions are asked not during the lectures, tutorials and labs. Questions asked by email will only be answered if they do not have educational value for other students, i.e. if you do not receive the answer within a day, ask your question through the Discussion Board.

2. Course Information

This course aims to introduce methods for visualizing data, especially in cases where simple plots and diagrams are insufficient. Information visualization and graphics rendering of abstract data involves various mathematical models, and has become important in modern science and technology. It has applications across many disciplines including interior and architectural designs, as well as engineering software systems that employ graphical presentations as part of their user interfaces. The students in this course will be immersed into “visual mathematics”, i.e. they will learn how to see geometry and colors beyond mathematical formulas and how to represent geometric shapes and motions by analytic functions and algorithmic procedures. They will develop spatial visualization skills which will permit them to perform 3D rotations and other transformations of geometric objects. They will also learn how a common personal computer, freeware and de-facto standard software can be used for solving complex computer graphics problems. The course requires knowledge of engineering math and analytic geometry.

By the end of this course, you should be able to:

1. Use geometry and colors as ways to visualize data beyond mathematical formulas.
2. Represent geometric shapes and motions by analytical functions and algorithmic procedures.
3. Use spatial visualization skills to perform 3D rotations and other transformations and motions of geometric objects.
4. Use a common personal computer and open source software to solve complex computer graphics problems.

Course Details

Lectures (26 hours):

Through the course, all the theoretical concepts are constantly illustrated with the practical examples using simple software which does not require programming skills. The students will merely fill in software templates with the mathematics definitions of the shapes, coordinate domain values and sampling parameters.

Introduction to computer graphics and foundation mathematics (2 hours)
Principles of visualization. Coordinate systems. Time as another dimension. Vectors and matrices. Vector and matrix algebra with application to geometric coordinate space. Geometric meaning of dot and cross products. Surface normal calculation.

Software Tool for Computer Graphics and Visualization (2 hours)
Introduction common software tools used in computer graphics and visualization projects. Introduction to the software to be used in the coursework.

Geometric shapes (10 hours)
Points, polygons, voxels, and procedural models. Analytical definitions of curves, surfaces, and solid objects. Shape animation and morphing. Principles of graphics rendering geometry.

Transformations and motions (4 hours)
Affine transformations. Translation, Scaling, Rotation. Composition of transformations. Motions definition.

Visual appearance (4 hours)
RGB colour model and light sources. Illumination calculation. Image texture mapping. 3D geometric textures. Appearance assignment to geometry.

Efficient rendering (2 hours)
Hierarchical representation. Spatial partitioning. Bounding volumes. Level of detail.

Putting it all together (2 hours)
Revision. Visualization as merging geometry and colours.

Tutorials:

Questions similar to the past year exam questions are discussed at the 12 tutorials. The students have to prepare their own solutions to the tutorial questions and submit them tio the tutors for evaluation before each tutorial. The marks and comments will be given back to the students at the end of the tutorial. The tutorial marks constitute **10% of the final mark** for the course.

Laboratories (10 hours) "Making Images wth Mathematics":

The same software that is used in the lectures is used in the 5 lab assignments. Both Windows running PCs as well as Apple Macs with OSX can be used for working on the lab assignments. Together with a possible remote desktop access to the computers with all the licenses installed, this approach allows the students to work on their assignments anytime anywhere. The labs will be evaluated at the end of the course. The lab mark will contribute **50% to the final mark** for the course.

Course-site:

The source codes used in the lectures are made available for the students through the course-site (NTULearn). The course site includes the lecture slides, tutorial questions, lab manual and the necessary software tools, additional materials above the lecture level such as URLs to the relevant web sites, videos, etc. There are many discussion groups set up in the course-site including consultations on lectures, tutorials and labs as well as additional discussion groups related to computer graphics. Some of the discussion topics are suggested by the students and there are also discussion groups inviting student proposals as well as accepting anonymous feedbacks. The results of the past lab experiements are shared in the course-site.

Text book:
Alexei Sourin, Making Images with Mathematics, Springer, 2021.

The book is available for free downloading from the NTU library.

3. Lab assignments submission

WITHIN ONE WEEK (7*24 HOURS) AFTER THE END OF EACH OF THE FIVE SCHEDULED LAB SESSIONS you have to do the following:

1. Create a folder and name it **exactly as your name is written on your matriculation card and add as a suffix the two last matriculation card number digits NM**, e.g., JAMES BOND 67.
2. Copy to this folder the scan/photo of your matriculation card with clearly readable name and at least three last characters of the matriculation number.
3. Copy to this folder all the .Func files and the PDF file of the report.
4. Zip your assignment folder. The zipped file **must have the same name as your folder**, e.g., JAMES BOND 67.zip.
5. Submit the zipped file through the respective digital drop box in the **lab website** (note that website has been created for each lab group).

Late submissions will be penalized. Check your email box regularly. The lab instructors or subject coordinator will email you if something is wrong.

4. Tutorial

The tutorials start on week 2. For each of 12 tutorials you have to prepare **written solutions** in a way how you do it during the exams and **email it in PDF format** to your tutors **before the respective tutorial. Late submissions will be rejected.** Tutorial groups assignment:

- Alexei Sourin: SCSE1 ✓
- Zheng Jianmin: SCSE2

Each tutorial can earn you:
- 1.0 mark if more than 60% is correct,
- 0.5 mark if 30--60% is correct,
- 0.0 mark if less than 30% is correct, or plagiarism, or no solution is submitted at all.

Note that the tutorial questions are **changed every semester**.

5. Policy on lab consultations and marks

You have a continuous assessment mostly based on the labs. It means that your examination is always on-going through the whole semester, and it restricts the lab marking and feedbacks to you to the following options:

- Each of the assignments will be awarded the allocated partial marks if the respective parts are correct, i.e. the correct shape is produced. Otherwise 0 mark will be awarded, i.e. it is either "all" or "nil" for each of the partial marks.
- As in the exams, while you are working on the lab assignments you can ask your lab instructors for clarification on the assignments however they **will not check or correct** your solutions.
- General questions about the lab assignments are addressed in the lectures and you are advised to watch them first before asking the instructors for help.
- Questions not addressed in the lectures can be asked **ONLY through the lab discussion group** so that there will be no misinterpretations, and every student may learn from such discussions. **Questions by email will not be answered.**
- After release of the marks for each lab, you can ask your lab instructors for a feedback. The lab instructors may choose different forms how to answer these questions. For example, it can be done by emailing to the whole group, or they may choose to email you back a screen-shot of the correct shape, and you can compare it with yours and think what you did wrong, or it can be merely a description of your faults. You cannot, however, ask for the correct formulas since the assessment is on-going for other groups and there are future labs which are not marked yet.
- Please forward your requests about marks strictly to your lab instructors according to the group allocation.