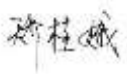
# 《计算机图形技术（双语）》本科课程教学大纲

# 《Computer Graphics Technology (Bilingual)》Syllabus

## 一、课程基本信息 Basic Information

<table>
<tr><td rowspan="2">课程名称<br>Course Name</td><td colspan="5">计算机图形技术（双语）</td></tr>
<tr><td colspan="5">Computer Graphics Technology (Bilingual)</td></tr>
<tr><td>课程代码<br>Course Code</td><td>2140021</td><td colspan="2">课程学分<br>Course Credit</td><td colspan="2">2</td></tr>
<tr><td>课程学时<br>Course Hour</td><td>32</td><td>理论学时<br>Theoretical Hour</td><td>16</td><td>实践学时<br>Experiment Hour</td><td>16</td></tr>
<tr><td>开课学院<br>Department</td><td>国际教育学院 College of International Education</td><td colspan="2">适用专业与年级<br>Major</td><td colspan="2">数字媒体技术（双语）二年级 Second year in Digital Media Technology(Bilingual)</td></tr>
<tr><td>课程类别与性质<br>Characteristic of the Course</td><td>专业必修课 Professional required courses</td><td colspan="2">考核方式<br>Assessment Method</td><td colspan="2">考查<br>course with the requirement to submit a term paper</td></tr>
<tr><td>选用教材<br>Teaching Materials</td><td colspan="5">视觉计算基础：计算机视觉、图形学和图像处理的核心概念，阿娣提·玛珠德，机械工业出版社，2019.4<br>Majumder A, Gopi M . Techniques: Core Concepts in Computer Vision, Graphics, and Image Processing[M]. 2018.</td></tr>
<tr><td>先修课程<br>prerequisites</td><td colspan="5">程序设计基础(C 语言)（4）、多媒体技术（2）<br>Fundamentals of C Programming Language(4)、Multimedia Technology(2)</td></tr>
<tr><td>课程简介<br>Course Description</td><td colspan="5">本课程作为一门新设计的概述性课程，旨在为学生提供计算机图形学、计算机视觉和图像处理等不同领域的基础知识，教师可以借助此课程教授这些领域共通的基础知识，让学生在进入计算机图形学、计算机视觉和图像处理中的具体领域之前有机会更广泛地学习相关知识。掌握视觉计算通用领域的广泛知识如今被认为是一个强项，能帮助学生轻松投身到大量使用视觉计算通用知识的计算机科学与其他领域的交叉领域。<br>As a newly designed overview course, this course aims to provide students with basic knowledge in different fields such as computer graphics, computer vision and image processing. Teachers can use this course to teach the common basic knowledge in these fields, so that students have the opportunity to learn more widely before entering the specific fields of computer graphics, computer vision and image processing. Mastering a wide range of knowledge in the general field of visual computing is now considered to be a strength, which can help students easily devote themselves to the cross fields of computer science and other fields, which use a lot of general knowledge of visual computing.</td></tr>
<tr><td>选课建议与学习要求 Suggestion</td><td colspan="5">该课程适合数字媒体技术学生在第二学年开设。<br>This course is suitable for digital media technology students in the sophomore</td></tr>
</table>

| | | | |
|---|---|---|---|
| **for Selection of Course** | year and junior year. | | |
| 大纲编写人<br>Tutor Signature |  | 制/修定日期<br>Date | 2023 年 9 月 |
| 专业负责人<br>Program Leader Signature |  | 审定日期<br>Date | 2023 年 9 月 |
| 学院负责人<br>College Leader Signature | 刘潇莹 | 批准日期<br>Date | 2023 年 9 月 |

## 二、毕业要求与课程目标 Graduation Requirements and Course Objectives

### （一）课程目标 Course Objectives

| 类型<br>Type | 序号<br>No. | 内容<br>Content |
|---|---|---|
| 知识目标<br>Knowledge objectives | 1 | 能够理解并掌握计算机图形技术和数字图像处理的原理及编程方法，并能够灵活运用相关知识，解决基本图像处理问题。<br>Be able to understand and master the principles and programming methods of computer graphics technology and digital image processing, and be able to flexibly apply relevant knowledge to solve basic image processing problems. |
| | 2 | 能够在理解图形图像处理原理基础上，使用相关图像处理软件，进行图形图像处理，并能通过比较分析，找出最佳解决方案。<br>On the basis of understanding the principles of graphics and image processing, be able to use relevant image processing software for graphics and image processing, and be able to find the best solution through analysis. |
| 技能目标<br>Skill objectives | 3 | 能够通过口头、书面、图表等方式，陈述作品制作过程，展示作品成果，分析解决作品问题，进行有效沟通交流。<br>Be able to present the process and final production through oral, written, or chart means, with effective communication, be able to solve problems. |
| 素养目标<br>(含课程思政目标)<br>Literacy goals | 4 | 能够利用课内外时间主动学习，关注行业动态新技术，通过自主学习发展自身能力，树立终身学习理念。<br>Being able to actively learn during and outside of class, paying attention to industry trends and new technologies, developing one's own abilities through self-directed learning, and establishing a lifelong learning philosophy. |

## （二）课程支撑的毕业要求 Graduation requirements supported by the Course

| |
|---|
| LO1工程知识：具备扎实的数学、自然科学、数字媒体领域工程基础和专业知识，能够将各类知识用于解决数字媒体领域的复杂工程问题。<br>③能够综合应用数学、物理、统计学、数字媒体领域工程基础知识和专业知识解决数字媒体领域复杂工程问题，能够分析解决方案的可行性与复杂性评价并确定解决方案。<br>LO1 Engineering Knowledge: Possess a solid foundation and professional knowledge in mathematics, natural sciences, and digital media engineering, and be able to apply various knowledge to solve complex engineering problems in the field of digital media.<br>③ Be able to apply mathematical, physical, statistical, and digital media engineering fundamentals and professional knowledge to solve complex engineering problems in the field of digital media, analyze the feasibility and complexity of solutions, evaluate and determine solutions. |
| LO5使用现代工具：能够针对数字技术领域复杂工程问题，选择与使用恰当的技术，使用媒体创作、虚拟现实、资源管理等软件工具，进行设计与开发，并能够针对工程应用需求，在通用工具基础上二次开发或定制。<br>①理解计算机专业设计的现代仪器、软硬件平台，开发测试工具、配置管理工具、信息检索工具的原理和使用方法及其局限性。<br>LO5 uses modern tools: be able to select and use appropriate technologies for complex engineering problems in the digital technology field, using software tools in media creation, virtual reality, and resource management to design and development, and be able to develop or customize system based on general tools according to engineering application requirements.<br>① Understand the principles and methods of modern instruments, software and hardware platforms designed for computer science, as well as the limitations of developing and testing tools, configuration management tools, and information retrieval tools. |
| LO10沟通：能够就数字媒体领域复杂工程问题与业界同行及社会公众进行有效沟通和交流，包括撰写报告和设计文稿、陈述发言、清晰表达或回应指令。并具备一定的国际视野，能够在跨文化背景下进行沟通和交流。<br><br>①能通过口头、书面、图表等方式就数字媒体技术与系统相关复杂工程问题与业界同行及社会公众进行有效沟通和交流。<br><br>LO10 Communication: be able to effectively communicate with industry peers and the public on complex engineering issues in the digital media field, including writing reports and design drafts, presentation, and responding to instructions. And possess international perspective, be able to exchange ideas in cross-cultural contexts.<br><br>① Can effectively communicate and exchange complex engineering issues related to digital media technology and systems with industry peers and the public through oral, written, charts, and other means. |
| LO12终身学习：具有自主学习和终身学习的意识，有不断学习和适应发展的能力。<br>③能够采取适合的方法通过自主学习发展自身能力，并表现出学习和探索的成效。<br>LO12 Lifelong Learning: Possess awareness of self-directed and lifelong learning, and have the ability to continuously learn and adapt to development.<br>③ Be able to adopt appropriate methods to develop one's own abilities through self-directed learning and demonstrate the effectiveness of learning and exploration. |

## （三）毕业要求与课程目标的关系 The Correlation between Graduation Requirements and Course Objectives

| 毕业要求 | 指标点 | 支撑度 | 课程目标<br>Course Objectives | 对指标点的贡献度 |
|---|---|---|---|---|

| Graduation Requirements | Index point | supporting degree | | Contribution to index points |
|---|---|---|---|---|
| LO1 | ③ | L | 1. 能够理解并掌握计算机图形技术和数字图像处理的原理及编程方法，并能够灵活运用相关知识，解决基本图像处理问题。<br>Be able to understand and master the principles and programming methods of computer graphics technology and digital image processing, and be able to flexibly apply relevant knowledge to solve basic image processing problems. | 100 |
| LO5 | ① | H | 2. 能够在理解图形图像处理原理基础上，使用相关图像处理软件，进行图形图像处理，并能通过比较分析，找出最佳解决方案。<br>On the basis of understanding the principles of graphics and image processing, be able to use relevant image processing software for graphics and image processing, and be able to find the best solution through analysis. | 100 |
| LO10 | ① | M | 3. 能够通过口头、书面、图表等方式，陈述作品制作过程，展示作品成果，分析解决作品问题，进行有效沟通交流。<br>Be able to present the process and final production through oral, written, or chart means, with effective communication, be able to solve problems. | 100 |
| LO12 | ③ | L | 4. 能够利用课内外时间主动学习，关注行业动态新技术，通过自主学习发展自身能力，树立终身学习理念。<br>Being able to actively learn during and outside of class, paying attention to industry trends and new technologies, developing one's own abilities through self-directed learning, and establishing a lifelong learning philosophy. | 100 |

# 三、课程内容与教学设计 Course Contents and Teaching Design

## （一）各教学单元预期学习成果与教学内容 Course Expected Learning Outcomes and Teaching Contents

**第 1 部分 预备知识 Part 1 Preliminary Knowledge**

通过本章学习，介绍各种不同的视觉数据（如二维图像、视频和三维几何数据），以及计算机图形学、计算机视觉和图像处理领域所需的核心数学技术（如插值和向量乘法）。

理论课时数 4，实践课时数 0。

Through the study of this part, we will introduce various visual data (such as two-dimensional image, video and three-dimensional geometric data), as well as the core mathematical technologies

required in the fields of computer graphics, computer vision and image processing (such as interpolation and vector multiplication).
Theoretical class hours 4, experiment hours 0.

**第 2 部分 基于图像的视觉计算 Part 2 image based visual computing**

通过本章学习，介绍处理二维图像的若干基本技术（如卷积、谱分析和特征检测），这些技术对应人类视觉系统中的低层视网膜图像处理。

本章重点是各种线性和非线性滤波器的使用，离散傅里叶变换以及各种特征检测。

理论课时数 2，实践课时数 8。

Through the study of this part, some basic technologies for processing two-dimensional images (such as convolution, spectral analysis and feature detection) are introduced, which correspond to the processing of low-level retinal images in human visual system.
This chapter focuses on the use of various linear and nonlinear filters, discrete Fourier transform and various feature detection.
Theoretical class hours 2, experiment hours 8.

**第 3 部分 基于几何的视觉计算 Part 3 geometric based visual computing**

通过本章学习，介绍用于综合多个视角的几何信息形成我们周围物体和世界的三维信息的基本技术（如线性变换、投影投影变换）。这相当于我们大脑中的高层处理技术，能够综合双眼看到的信息以帮助我们在三维世界中活动。

本章重点是理解并掌握计算机图形学中的虚拟照相机模型、模型变换（平移、旋转、缩放、剪切）和投影变换（透视投影、正交投影），理解局部坐标系和世界坐标系，知道齐次坐标。

理论课时数 4，实践课时数 2。

Through the study of this part, we will introduce the basic technologies (such as linear transformation and projection transformation) used to synthesize the geometric information of multiple perspectives to form the three-dimensional information of the objects and the world around us. This is equivalent to the high-level processing technology in our brain, which can integrate the information seen by our eyes to help us move in the three-dimensional world.
This part focuses on understanding and mastering the virtual camera model, model transformation (translation, rotation, scaling and cutting) and projection transformation (perspective projection and orthogonal projection) in computer graphics, understanding the local coordinate system and world coordinate system, and knowing the homogeneous coordinates.
Theoretical class hours 4, experiment hours 2.

**第 4 部分 基于辐射度的视觉计算 Part 4 visual calculation based on radiance**

通过本章学习，介绍为处理光线与我们周围物体交互过程中产生的信息所需的基本技术，涉及人类视觉系统中与光照相关的反射率、光强和色彩等属性，知道常用的颜色模型。

理论课时数 2，实践课时数 0。

Through the study of this part, we will introduce the basic technologies required to process the information generated during the interaction between light and objects around us, involving the reflectivity, light intensity, color and other attributes related to light in the human visual system, and know the commonly used color models.
Theoretical class hours 2, experiment hours 0.

**第 5 部分 视觉内容合成 Part 5 visual content synthesis**

通过本章介绍创建计算机虚拟世界的基本技术，该世界能够模拟前面介绍的所有处理技术，包括交互式图形流程以及真实感与性能。理解图形流水线；理解 Blinn-Phong 光照明模型、着色处理模型、如何使用纹理增强真实感。

本讲重点是光照、材质、纹理。

理论课时数 4，实践课时数 6。

This part introduces the basic technology of creating a computer virtual world, which can simulate all the processing technologies described above, including interactive graphics flow, realism and performance. Understand graphics pipeline; Understand Blinn Phong lighting model, shading model and how to use texture to enhance realism.
This lecture focuses on lighting, material and texture.
Theoretical class hours 4, experiment hours 6.

## （二）各教学单元对课程目标的支撑关系 The supporting relationship between each teaching part and the course objectives

| 课程目标 course objectives / 教学单元 teaching part | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 第 1 部分 预备知识<br>Part 1 Preliminary Knowledge | √ | √ | | |
| 第 2 部分 基于图像的视觉计算<br>Part 2 image based visual computing | | √ | √ | |
| 第 3 部分 基于几何的视觉计算<br>Part 3 geometric based visual computing | | √ | √ | |
| 第 4 部分 基于辐射度的视觉计算<br>Part 4 visual calculation based on radiance | | | | √ |
| 第 5 部分 视觉内容合成<br>Part 5 visual content synthesis | | √ | √ | √ |

## （三）教学方法与学时分配 Teaching methods and teaching hour

| 教学单元<br>teaching part | 教与学方式<br>Teaching and Learning Methods | 评价方式<br>Assessment Methods | 学时分配 teaching hour | | |
|---|---|---|---|---|---|
| | | | 理论<br>Theoretical | 实践<br>Experiment | 小计<br>total |
| 第 1 部分 预备知识<br>Part 1 Preliminary Knowledge | 授课 Lecture | 问题，章节测验 Multiple Questions, Quiz | 4 | 0 | 4 |
| 第 2 部分 基于图像的视觉计算 Part 2 image based visual computing | 授课、讨论、案例分析<br>Lecture, Discussion, Case Study | 各类问题，章节测验，案例学习 Multiple Questions, Quiz, Case Study | 2 | 8 | 10 |
| 第 3 部分 基于几何的视觉计算 Part 3 geometric based visual computing | 授课、讨论、案例分析<br>Lecture, Discussion, Case Study | 各类问题，章节测验，案例学习 Multiple Questions, Quiz, Case Study | 4 | 2 | 6 |
| 第 4 部分 基于辐射度的视觉计算 | 课外自主学习<br>Autonomous | 团队项目<br>Team work | 2 | 0 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| Part 4 visual calculation based on radiance | Learning | | | | |
| 第 5 部分 视觉内容合成 Part 5 visual content synthesis | 授课、讨论、案例分析 Lecture, Discussion, Case Study | 各类问题，章节测验，案例学习 Multiple Questions, Quiz, Case Study | 4 | 6 | 10 |
| 合计 total | | | 16 | 16 | 32 |

**（四）课内实验项目与基本要求 In-Class Experiment and Basic Requirements**

| 序号 No. | 实验项目名称 Name of Experiment | 目标要求与主要内容 Main Content of the Experiment | 实验时数 Experiment Hours | 实验类型 Experiment Type |
|---|---|---|---|---|
| 1 | 计算机视觉入门 Introduction to computer vision | 通过实验，帮助学生更好地掌握计算机视觉相关概念和技术，使学生对图像滤波、边缘检测、谱分析、几何变换等有比较深入的认识。Help students master the concepts and technologies related to computer vision, and have an in-depth understanding of image filtering, edge detection, spectral analysis, geometric transformation, etc. | 8 | 验证型 Verification |
| 2 | 计算机图形学入门 Introduction to computer graphics | 在 tutors 软件中通过调整参数，完成三维图形的变换、投影、纹理等效果，理解计算机图形学渲染管线。In the tutors software, by adjusting the parameters, the transformation, projection, texture and other effects of 3D graphics are completed, and the rendering pipeline of computer graphics is understood. | 8 | 验证型 Verification |

实验类型：①演示型 ②验证型 ③设计型 ④综合型

## 四、课程思政教学设计 Course Ideological and Political Education Design

1．通过图形图像处理基础知识学习，形成严谨的逻辑思维，培养科学态度。

By learning the basic knowledge of graphics and image processing, form rigorous logical thinking and cultivate a scientific attitude.

2．能够利用课内外时间主动学习，关注行业动态新技术，树立终身学习理念。

Able to actively learn within and outside of class, pay attention to industry trends and new technologies, and establish a lifelong learning philosophy.

## 五、课程考核 Course Assessment

| 总评构成 **Grading Computation** | 占比 **Weightage** | 考核方式 **Assessment Index** | 课程目标 **Course Objectives** | | | | 合计 **Total** |
|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | |
| X1 | 50% | 个人项目报告<br>Final Personal Report（2000 words） | | 60 | 40 | | 100 |
| X2 | 20% | 过程考核：个人作业<br>Personal Work（800 words） | 40 | 60 | | | 100 |
| X3 | 20% | 过程考核：小组团队作业<br>Team Work（1200 words） | | | 60 | 40 | 100 |
| X4 | 10% | 过程考核：课堂表现、出勤等<br>Class Performance | 30 | 50 | | 20 | 100 |