Human-Computer Interactions: VR/AR

Instructor Information:
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Course Description:
This course explores the integration of Artificial Intelligence (AI), Deep Learning, and Large Language Models (LLMs) within Spatial Computing, with a particular focus on AR/VR application development. Participants will gain comprehensive knowledge of spatial computing concepts, deep learning algorithms, particularly YOLO, and using LLMs to enhance explainability and interaction in AR/VR environments.

Course Objectives:

- Understand spatial computing foundations and the role of AI and deep learning.
- Develop AR/VR applications with Unity, integrating AI and LLMs.
- Apply LLMs for improved explainability in AR/VR applications.
- Enhance problem-solving, creativity, and communication skills within spatial computing.

Project Team Formation Participants are encouraged to form teams of 2 or 3 to complete assignments and develop projects. These projects will be presented on March 2 (Saturday).

Access to Plaster Center #206 (AR/VR Room)

- The Plaster Center #206 (AR/VR Room) is available for use from February 20 to March 15, 2024. Access is granted via your student card.
- To log in to the machines, use the password: student
- VR devices must only be used within Room #206 and are not to be removed from the room.

Feb. 24 (Saturday): 9AM-Noon

- **UMKC Students**: Plaster Center #206.

- **MU Students:**
    - Zoom: https://umsystem.zoom.us/j/2174320035?pwd=b1lRVTZ1enpYYWQ3dzVacFBiRC9CUT09
    - Meeting ID: 217 432 0035
    - Passcode: UMKC

Mar. 2 (Saturday): 9AM - Noon

- **UMKC Students**: Plaster Center #206.
- **MU Students:**
    - Zoom: https://umsystem.zoom.us/j/2174320035?pwd=b1lRVTZ1enpYYWQ3dzVacFBiRC9CUT09
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    - Passcode: UMKC

Software/hardware Requirements:

- Google account for Colab (https://colab.google/)
- Github account (https://github.com/)
- Python 3.9 (https://www.python.org/downloads/release/python-390/)
- PyCharm (https://www.jetbrains.com/pycharm/)
- Unity 2022 (check the system requirements https://docs.unity3d.com/Manual/system-requirements.html)
- Visual Studio Code (https://code.visualstudio.com/)
- Oculus quest 2 (https://www.meta.com/quest/)

Learning Material: The session on February 24 (Saturday) from 9:00 AM to 12:00 PM will cover the following:

- **Lecture 1 & 2 PowerPoint Slides:** Download here
- **Tutorial 1 - Deep Learning with YOLO:** Access Tutorial
    - **Assignment 1:** Complete Assignment
- **Tutorial 2 - Unity and VR:** Access Tutorial
    - **Assignment 2:** Complete Assignment

Lesson Breakdown and Expected Learning Outcomes:

Week 1: Lesson 1

- **Lecture 1:**
    - Learn spatial computing and AI basics.
    - Conceptualize an AI-driven spatial computing application.
- **Tutorial 1:**
    - Basics of Machine Learning (ML) and Deep Learning
    - Relationship between Machine Learning and Deep Learning, with emphasis on Convolutional Neural Networks (CNNs)
    - Introduction to YOLO (You Only Look Once)

        - Training a custom YOLO object detection model from scratch using Darknet
- **Assignment 1:**
    - Practical exercises to enhance Machine Learning and Deep Learning skills
    - Utilization of popular Python libraries such as Scikit-learn, NumPy, and Pandas
    - Training a custom YOLO model
    - Selection of a dataset for training the model
    - Application of custom data augmentations to prepare for model training
    - Hands-on experience in building and refining a deep learning model for object detection

Learning Outcome: Understand spatial computing's role across industries and the foundational principles of AI and deep learning.

Week 1: Lesson 2

- **Lecture:**
    - Explore Advanced deep learning integration.
    - Enhance the initial concept with AR/VR features.
- **Tutorial:**
    - Exploring object detection in virtual reality (VR) using Oculus Quest 2
    - Focusing on detecting various fruits using a YOLO object detection model
    - Utilizing Unity for VR development
    - Implementing object detection with YOLO (You Only Look Once)
    - Incorporating Flask as the Python web framework
    - Coding with PyCharm for Flask development and Visual Studio Code for C# programming in Unity
- **Assignment: Custom Object Detection in Unity**
    - Training a YOLO model with a custom dataset for object detection in Unity
    - Incorporating custom objects or environments from the internet
    - Optionally recording personal environments or objects using 3D scanning apps, subject to device compatibility

Learning Outcomes: Gain hands-on experience with spatial data analysis and learn to enhance AR/VR applications using AI and Unity.

Week 2: Lesson 3

- **Lecture:**
    - Advance in spatial data analysis using SLAM (Simultaneous Localization And Mapping).
    - Explainability using LLMs for Spatial Computing
    - Further develop the AR/VR application with AI interactivity.

- **Tutorial:**
    - Introduction to advanced integration of Unity, YOLO, Flask, Large Language Models (LLM), and SLAM (Simultaneous Localization And Mapping) scanning
    - Creating an interactive spatial environment for robust object detection
    - Utilizing SLAM for a deeper understanding of surroundings and spatial context
    - Integration of LLMs to process and interpret detected objects within their spatial environment
- **Assignment**: SLAM-Enabled Object Detection with LLM Insights
    - Enhancing YOLO model training with a custom dataset for object detection within a SLAM-enabled environment
    - Integrating SLAM technology to understand the spatial context of detection
    - Utilizing LLM prompts to extract deeper insights and explanations from object detection results
    - Enriching the interactive experience with spatial awareness and interpretative depth

Learning Outcome: Develop skills in SLAM and LLMs and deep learning model integration for AR/VR.

Week 2: Session 4: Project Review/Presentation

- Finalize AR/VR metaverse application with advanced AI and LLM features.
- Prepare and deliver final presentations.

Learning Outcome: Achieve proficiency in advanced AR/VR application development and integration of deep learning and LLMs for spatial computing applications.

Evaluation Criteria:

- Assignments (30%): Creativity, technical execution, and AI integration.
- Final Project (30%): Innovation, practicality, and explainability.
- Participation (40%): Active engagement in class and project development.

Learning Materials:

- Lecture slides and notes.
- Unity and AI/LLM software guides.
- Case studies on AI and spatial computing.

Prerequisites:

- Basic Python programming.
- Understanding of AI/machine learning fundamentals.
- No prior Unity or AR/VR experience needed.

Additional Information:

- Focus on teamwork and project-based learning.
- Office hours available for additional support.