GUJARAT TECHNOLOGICAL UNIVERSITY

BACHELOR OF ENGINEERING SYLLABUS

Subject Code : 3155205

Subject Name : Virtual Reality and Immersive Technology

WEF Academic Year:	2021-22
Semester:	5
Category of the Course:	Professional Elective V

Prerequisite:
Computer Graphics

Rationale:

The objective of this course is to provide a foundation to the fast-growing field of VR and AR. This course presents an introduction to virtual and augmented reality technologies, with an emphasis on designing and developing interactive virtual and augmented reality experiences. The course will cover the history of the area, fundamental theory, and interaction techniques. Students are provided with hands-on experience developing applications for modern virtual and augmented reality systems. In the course, students will also explore libraries and tools for creating AR/VR experiences such as Vuforia and UNITY.

Course Scheme :

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Course Content :

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Introduction to Virtual Reality** Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Applications of Virtual Reality	4	10%

2	**Rendering VR & Interaction with VR** Representation of the Virtual World Visual Representation in VR, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Interacting with The Virtual Reality, Key Interactions: Manipulation, Navigation, and Communication	6	15%
3	**Introduction to Augmented Reality** Defining augmented reality, history of augmented reality, The Relationship Between Augmented Reality and Other Technologies, Applications of Augmented Reality	4	10%
4	**Tracking & Sensors** Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion. **Computer Vision for Augmented Reality** Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking, Marker-less approach	6	20%
5	**Mixed Reality** Introduction to mixed reality, Applications of mixed reality, Input and Output in Mixed reality, simultaneous localization and mapping (SLAM), variants of SLAM - dense tracking and mapping (DTAM), parallel tracking and mapping (PTAM) and semi-direct monocular visual odometry (SVO).	6	10%
6	**VR App Development with Unity** VR SDK's – VR SDK'S and Frameworks – OpenVR SDK, StreamVR SDK, VRTK, Oculus SDK, Google VR SDK. VR Concept Integration-Motion Tracking, Controllers, Camera, Hardware and Software requirements Setting up Unity with VR- Framework/SDK Integration with Unity, Debugging VR projects, Unity XR API's, Mobile VR Controller Tracking, Object Manipulation, Text optimizing and UI for VR	7	15%
7	**AR App Development with Unity** Unity AR concepts- Pose tracking, Environmental detection, Raycasting and physics for AR, Light estimation, Occlusion, working with ARCore and ARKit Working with AR Tools– ARCore, ARToolkitx ARCore - Features of ARCore, integration with Unity/Unreal/iOS/Android Studio. ARToolkit – Features of ARToolkit, setting up the environment for application development. Vuforia- Features of Vuforia, setting up the environment for application development.	8	20%

Reference Book :

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016), ISBN-10: 9332578494
4. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381
5. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13: 978-1838648183 2.
6. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436

Course Outcome:

After Completion of the Course, Student will able to :

No	Course Outcomes	RBT Level*
01	Understand how VR systems work and list the applications of VR.	UN
02	Understand how AR systems work and list the applications of AR.	UN
03	Understand computer vision concepts for AR and describe AR techniques	UN
04	Design and prototype effective AR/VR applications using UNITY platform for business, industry, non-profit and government organizations	CR

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Suggested Course Practical List:

(Pl Note: List of practical are suggestive in nature. Faculty can add more practical / case-studies)

1. Create a virtual environment for any use case. The application must include at least 4 scenes which can be changed dynamically, a good UI, animation and interaction with game objects. (e.g VR application to visit a zoo).
2. Study the design of an AR application with C# and Unity.
3. Study all the available AR toolkits.
4. Study on enhancement and improving markers with Vuforia engine.
5. Study of Microsoft Hololens.
6. Study about VR device interaction and working with OS(Windows/Linux) and IDE's (Unity/Unreal).
7. Effect of any VR game on health.(Beat Saber/Rick and Morty: Virtual Rick-Ality/ Cloudlands VR Minigolf)
8. What is Google Maps AR navigation and how it is used?
9. A Mini-Projects / Case Study for a group of students

Design Based Problems / Open Ended Problems

1. Installation of Unity or equivalent Open Source Tool / Platform and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2. Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
3. Develop a scene in Unity that includes: i. a cube, plane and sphere, apply transformations on the 3 game objects. ii. add a video and audio source.
4. Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the colour, material and texture of each Game object separately in the scene. Write a program in visual studio to change the colour and material/texture of the game objects dynamically on button click.
5. Develop a scene in Unity that includes a sphere and plane. Apply Rigid body component, material and Box collider to the game Objects. Write a program to grab and throw the sphere using VR controller.
6. Develop a simple UI (User interface) menu with images, canvas, sprites and button. Write a program to interact with UI menu through VR trigger button such that on each successful trigger interaction display a score on scene.

7. Create an immersive environment (living room/ battlefield/ tennis court) with only static game objects. 3D game objects can be created using Blender or use available 3D models.
8. Include animation and interaction in the immersive environment created in practical 7.

List of Laboratory/Learning Resources Required:

- Getting started with AR development in Unity https://docs.unity3d.com/Manual/AROverview.html
- Getting started with Vuforia engine in Unity - https://library.vuforia.com/articles/Training/getting-started-with-vuforia-in-unity.html
- Immersive Computing at Google - https://www.youtube.com/watch?v=ZHIY6Uwmk-8
- XR - The Future of VR, AR & MR in One Extended Reality https://www.youtube.com/watch?v=E0QLVj9FJ0A
- Simultaneous Localization and Mapping – https://blogs.nvidia.com/blog/2019/07/25/what-is-simultaneous-localization-and-mapping-nvidia-jetson-isaac-sdk/ https://people.eecs.berkeley.edu/~pabbeel/cs287-fa09/readings/Durrant-Whyte_Bailey_SLAM-tutorial-I.pdf https://www.mathworks.com/discovery/slam.html
- Dense Tracking & Mapping - https://github.com/Rintarooo/dtam-1

MOOC Courses:

- https://nptel.ac.in/courses/106/106/106106138/
- https://www.coursera.org/learn/introduction-virtual-reality
- https://www.coursera.org/learn/augmented-reality
- https://www.coursera.org/specializations/unity-xr

* * * * * * *