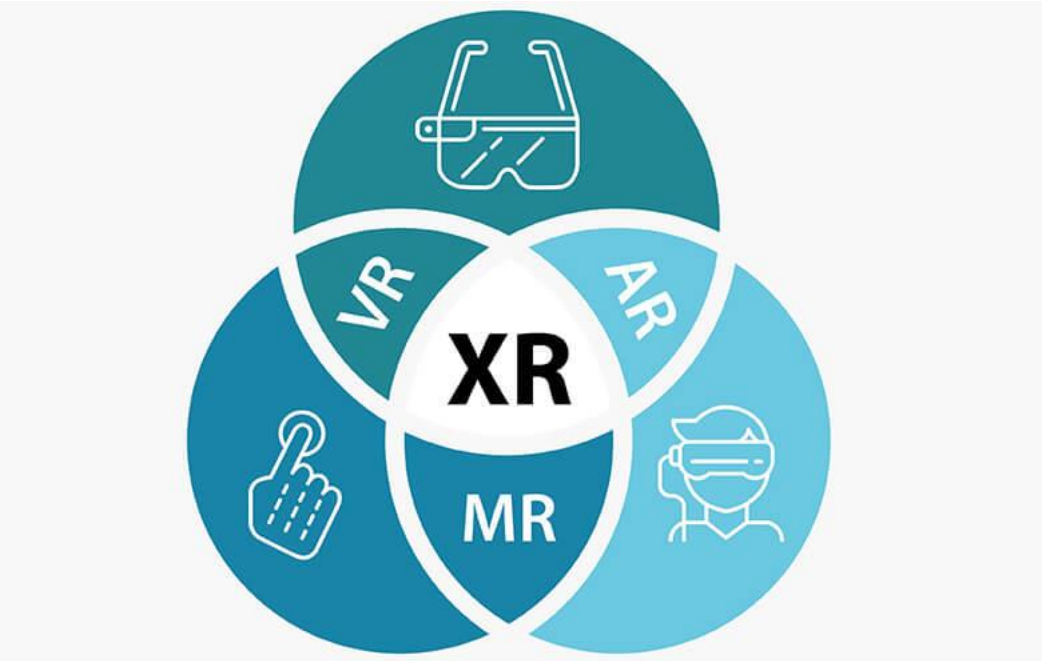
# Center for Extended Reality (CXR)




GITAM (Deemed to be University), GIT,
Rushikonda, Visakhapatnam

# 1. GENERAL INTRODUCTION

## 1.1. Context

The recent advancements in hardware and computing power have led to new developments in virtual and augmented reality, computer graphics and vision, and machine learning. Imagine what would it be like living in 2030 and beyond, where the customer, who wants to buy a land from a real-estate company will be able to experience the land and its surroundings at the comfort of their home or experience the house that is about to be built. It is estimated by 2022 the XR market is expected to grow $209 billion, which is eight times what is today. This tremendous growth could mean the realities of our 2030 lives are beyond our imagination's ability to grasp. To explore this new technology and its applications, the GITAM XR labs will offer hardware, support along with expertise, and dedicated workspaces to further the technology growth through research and development.

## 1.2. What is Extended Reality (XR)?

Extended Reality (XR) is an emerging area that includes all the immersive technologies like Augmented Reality (AR), Virtual Reality (VR), and Mixed reality (MR) as representative form plus those that are yet to be created. These immersive technologies will extend the reality that we experience by blending the virtual and real worlds or by creating a fully separate immersive experience. According to the recent qualitative research, more than 60% of the respondents believed that XR will be the mainstream in the next five years.

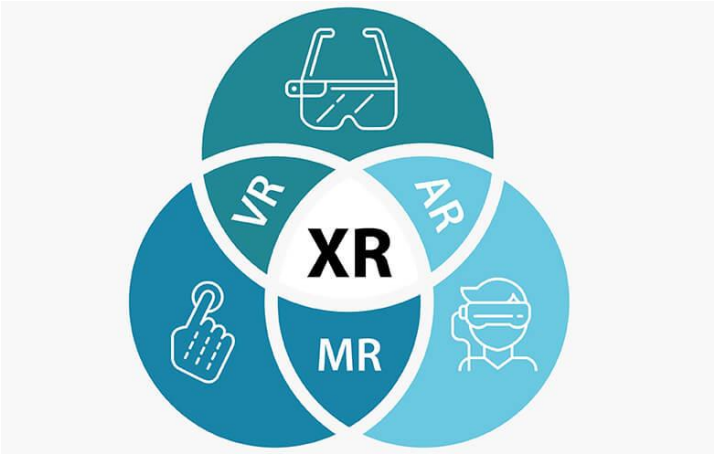



***Figure 1: The three representative forms***

**1.2.1.** **Augmented reality** (**AR**) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced or extended by computer-generated perceptual information (that includes animations, text etc), sometimes across multiple sensory modalities such as visual, audio, haptic etc., This AR mainly incorporates three things such as a combination of real and virtual worlds, a real time interaction and an accurate 3D registration of virtual and real world objects. Simply, it is defined as the extension of real world with the virtual content sometimes across multiple sensory modalities

**1.2.2.** **Virtual Reality (VR)** is a simulated experience, where the user is immersed in the environment that may be looking same as a real world or completely a new one. Users are generally immersed in a virtual environment and the examples for virtual reality applications are gaming, driving simulations, pilot training, virtual science labs etc.,

**1.2.3.** **Mixed Reality (MR)** is a combination of both virtual and real world objects. This a technology which allows the virtual and real world objects to co-exist and

interact with each other. With the blend of these two Mixed reality is a mix of virtual reality and augmented reality to form new environments.

## 2. GITAM CENTER FOR EXTENDED REALITY

### 2.1. Vision of XR Research lab

Our vision is to demonstrate research excellence by addressing strategically important challenges in the field of Extended Reality that have economic and social impact, through research, knowledge exchange and/or collaborations.

### 2.2. Aim for the Research center

GITAM envision to be an influential player in Academics along with Research and Development. To produce effective leaders and effective workforce in a relevant field GITAM proposed to create and develop 5 centers of excellence within the campus. XR Lab is one of them. We aim to make this XR lab a technological hub with the state-of-the-art virtual and augmented reality devices, much-needed computers, motion and gesture detection devices, haptics, 3D scanners etc. We intend to provide a space where researchers, graduate and post graduate students, start-ups, and industries come together and address the needs of XR.

The lab is intended to address the challenges of AR/VR which lies in several areas such as medicine, gaming, training, sports, storytelling, education, and demonstrations.

This Extended Reality (ER) Lab is intended to put **major emphasis** on futuristic interaction technologies including **virtual, augmented and mixed reality.**

The main focus is on **promoting** this ER Lab into a **Center of Excellence** by developing a community of empowered students and faculty in the area of Augmented, Virtual and mixed reality, through multiple collaborations with both well established Industry and Academic AR/VR centers.

This lab will engage in AR/VR **curriculum development** along with **teaching, research**, and services for developing advanced methods and algorithms for near-real 3D user interfaces and exploratory data analysis in virtual environments.

Emphasis will also be laid **on application-driven, interdisciplinary research** by extending the collaborations in future with all the reputed institutions worldwide, and partners from industry, covering fields like medicine, defence, simulation science, production technology, product development, neuroscience and architecture.

We aim at providing a platform for students to work on this futuristic technology and also encourage them to join one of the available projects with our research and industry partners either through their curriculum or as a resident graduate student.

Through XR lab, we aim to offer hardware and expert support for the researchers. This XR lab also plays a role in bringing the researchers and students into contact for collaborative work on some interesting projects.

## 2.3. Objectives

- To focus on the growth & development of Augmented and Virtual Reality solutions for achieving the digital transformation. This Lab **aims at partnering with industry, academia, R&D L**abs and innovators. The following are the major objectives of Extended Reality Lab, GITAM

- Giving a **push to research, technology development**, product development, technology incubation and entrepreneurship in Virtual Reality and Augmented Reality

- Develop a **state-of-the-art research and development with a testing lab facility** for advanced algorithms that involves mathematical modelling for simulating and tackling the real world engineering problems using AR/VR technology.

- Partnering with the industry and developing the application platforms for **specific skill development** programs based on the industry needs and relevance.

- **Encouraging and producing enthusiastic new generation entrepreneurs** who are ready to establish a start-up and reap the benefits of incubation and start-up facilities in collaboration with Venture development Cell (VDC).

- To create a **core group of researchers** in the area of Augmented Reality and Virtual Reality.

- To **train and encourage students to develop in-house needs** like Virtual Science Labs, Virtual Anatomy Lab etc;

- To provide **training to the faculty to handle courses and projects** related to Immersive visualization, Augmented reality, AR/VR Gaming etc.,

## 2.4. Approach

We intended to divide the Activities into Three divisions as follows:

1. Augmented Reality
2. Virtual Reality
3. Touch and Haptics

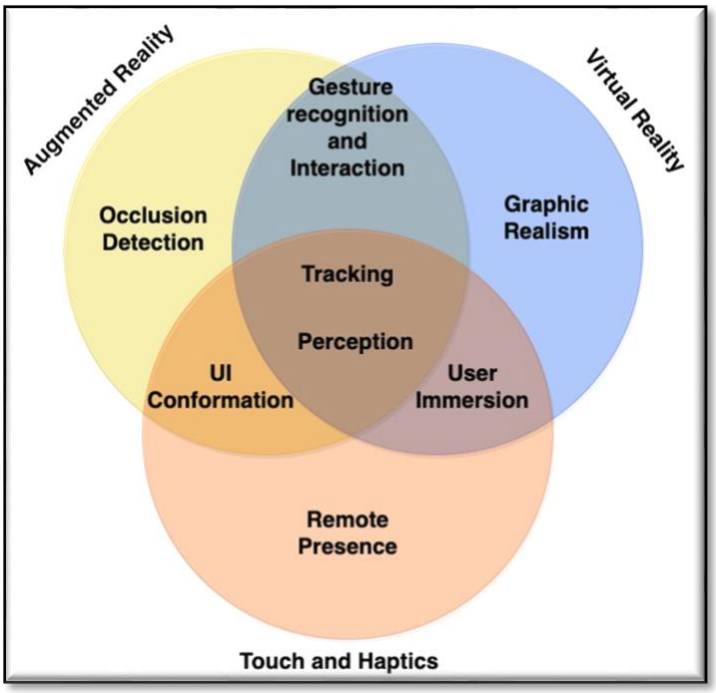



***Figure 2: Proposed Areas of work***

### 2.4.1. Work Areas

As shown in Figure 2 the following are the areas that will be focused by Center of Excellence for Extended Reality, some of these areas fall under 2 or more divisions.

a. Occlusion Detection
b. Gesture Recognition and Interaction
c. Tracking
d. Perception
e. Graphic Realism
f. UI conformation
g. User immersion
h. Remote Presence

**a. Occlusion Detection**: Handling occlusion between real and virtual objects is a challenging problem in Augmented Reality (AR) applications. Incorrect and inaccurate occlusion handling may cause confusion in users' perception which leads to non-realistic and non-immersive AR experiences. Still there are many challenges that lay ahead in occlusion handline. We focus on various evolving techniques for handling occlusions in augmented reality

**b. Gesture Recognition and Interaction**: In both Augmented reality and virtual reality, interaction between user and the device plays an important role in giving the user a pleasant immersive experience. Modern AR displays such as the **Hololens2** support

natural two-handed gesture input, allowing people to reach out and grab virtual content. However, a combination of speech and gesture together can be used to create multimodal interfaces where the strengths of one modality compensates for the weakness of another. In addition to eye-tracking, full-body input using **(Microsoft Kinect)**, and other non-verbal cues can provide even more intuitive multimodal interaction. Research also needs to be conducted into interaction methods using techniques not possible in the real world. Brain computer interaction methods enable brain activity to select AR content and other physiological sensors can enable AR to respond to user heart rate or emotional state. There are many opportunities to create even better AR interaction methods.

c. **Tracking** : Tracking technology has improved significantly, but another Grand Challenge is to precisely locate a user's position in any location. There has been a significant amount of research on computer vision methods for tracking user viewpoint without knowing any visual features. However, one area that we can take advantage of is less hybrid approaches for very large-scale tracking.

d. **Perception** : Perception is one challenging task which can be considered as belonging to all the three divisions. In addition to Grand Challenges in fundamental technology, there are other areas of AR that need to be addressed, such as exploring perceptual and neuroscience issues. AR systems generally create an illusion, that which convinces the brain that virtual content actually exists in the real world. There are problems with the perception, that can occur in AR, classified into environmental, capturing, augmentation, display device, and user issues. According to some studies considerable amount of research has been conducted to make AR content appear the same as real objects, including the use of virtual lighting, shadows, real object **occlusion** (and similar methods. The goal is to create digital objects that have strong "Object Presence" and appear to be really there. However, unlike Presence in Virtual Reality, Object Presence in AR has not been well studied. This is where we intend to focus on.

e. **Graphic Realism**: Realistic looking graphics is a challenge in virtual reality. Careful rendering can create a more realistic. The reflection, shadows, lighting etc., should be represented in the Virtual world for every object along with the virtual objects in the real world in augmented reality. How can a user come to believe that what is being visualized is a real one? It is when the virtual objects in the real world will be having the same reflection and shadows as the real world objects in the surrounding environment. Applying machine learning and artificial intelligence can really solve these problems. As graphic realism is still a challenging aspect we decided to work on this area.

f. **UI conformation**: It is part of haptics. This User Interface conformation can be obtained in AR and VR using "data gloves" or "sensory gloves" or "haptic gloves". In the real world any button we press gives us the feedback, but in the virtual world feeling a sense of touch and getting a feedback from a pressed or touched virtual button is a challenge. Most data gloves or the haptic gloves that are available in the market are quite user customizable and can be programmed for a particular scenario where a touch feedback is necessary.

g. **User Immersion**: To illustrate user immersion, here is a basic example is the recoil of a weapon when a shot is fired in an XR game. If the user can feel this haptic feedback, then the experience is even more immersive. It also gives the opportunity to enrich haptic textures with specific perceptions.

h. **Remote Presence**: For awareness, this is referring to the context and the virtual environment. Awareness in haptics for extended reality can be used to give directions to the user or warn him that something is happening. It acts almost like a 6th sense. Indeed, information are supplied to the user through the sense of touch, without overcharging sight or hearing.

### 2.4.2. Activity Divisions

Based on the aim and objectives that we have set in the earlier section, we have divided the activities into 3 verticals, Planning and Training vertical, Research and Innovation vertical, Business Development vertical.

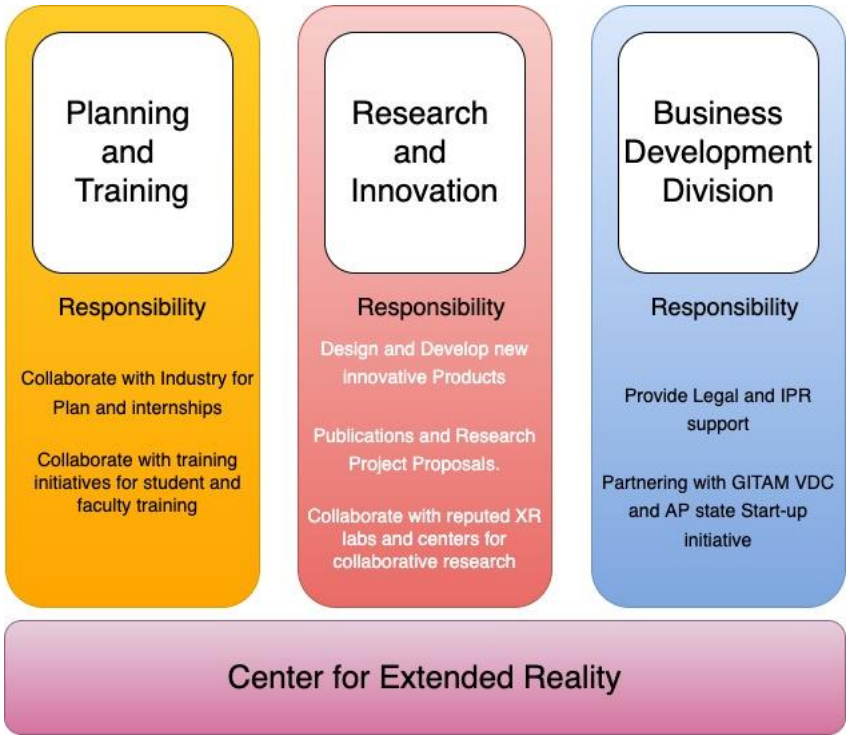



***Figure 3 : Planned Verticals for CXR***

**Planning and Training**: This vertical will have group of professionals, who in collaboration with Industry and training initiative institutes will decide on future technological fields in XR, which can be incorporated for training the students. This vertical is responsible for training and providing the opportunities for student internships in their respective fields. This vertical is responsible for training collaborations with current AR/VR Industry

**Research and Innovation**: This vertical will be lead by group of researchers from various departments who will work together to bring interdisciplinary work environment. This verticals is responsible design and develop new innovative products such as software and hardware as part of Futuristic Technology Development Initiative. This vertical is responsible for publications and research project proposals in collaboration with industry. This vertical is responsible for collaborating with National and International reputed XR labs for research collaborating and exchange programs for research scholars.

**Business Development Division:** This vertical will provide Legal/Regulatory support, Patents and Intellectual Property Rights (IPR) support, Clinicals and Claims support, and Project Management support. Working seamlessly with partners such as the GITAM Venture Development Centre (VDC) and Andhra Pradesh start-up incubation initiative.

will provide the necessary infrastructure, facilities, expertise and mentorship to bring ideas to the market – all in one integrated set-up.

### 2.4.3. Process

In the below diagrams we have mentioned the process Planning and Training, Research and Innovation follow to achieve their goals

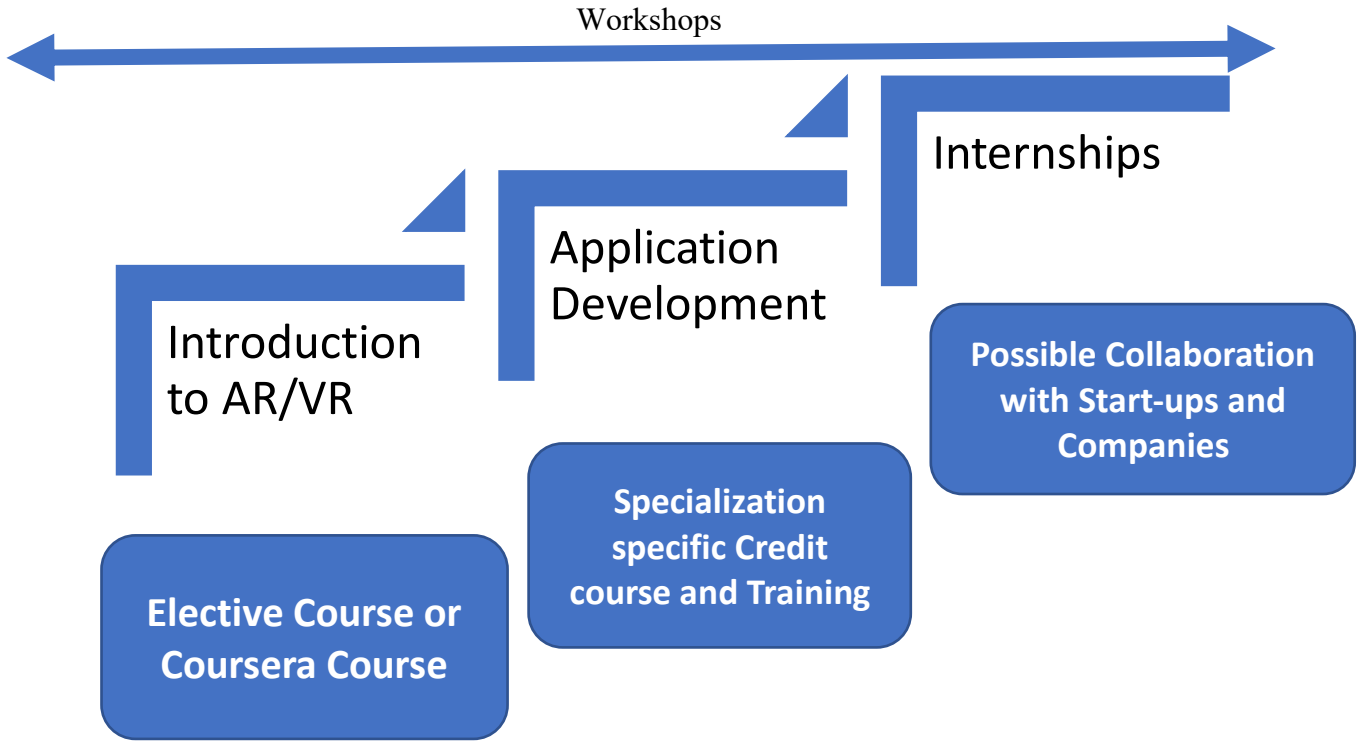



*Figure 4: Process Planning for Planning and Training*

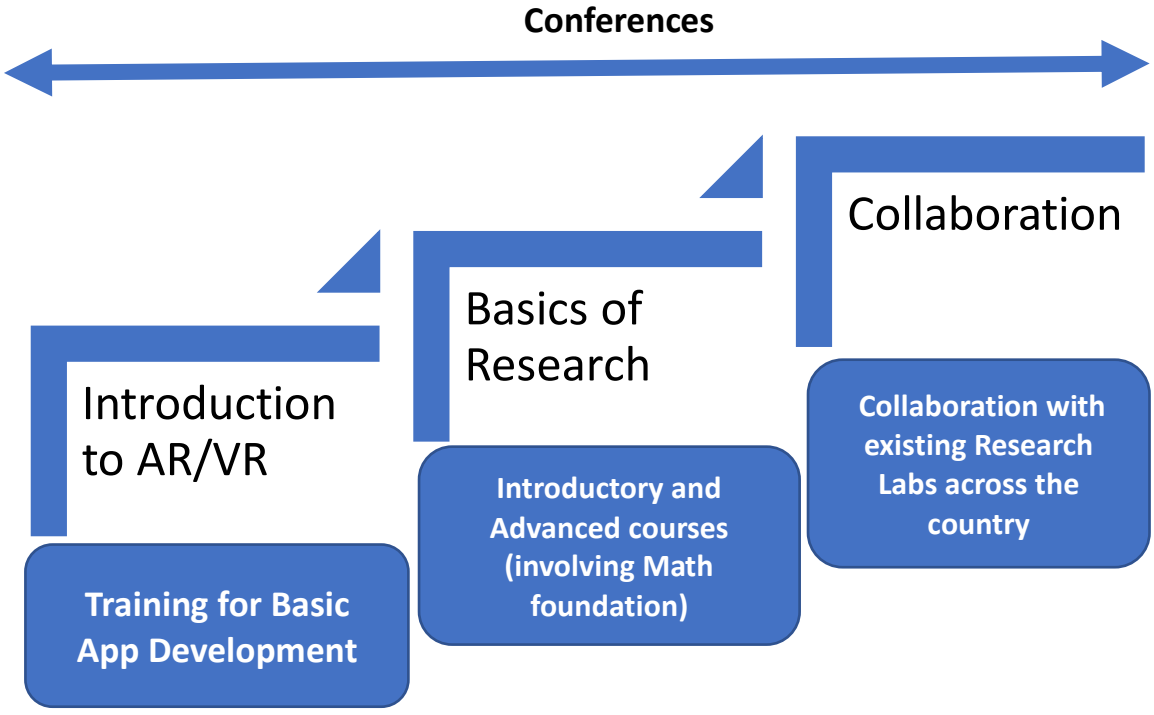



*Figure 5: Process Planning for Research and Innovation*

## 2.5. Six Month Planning

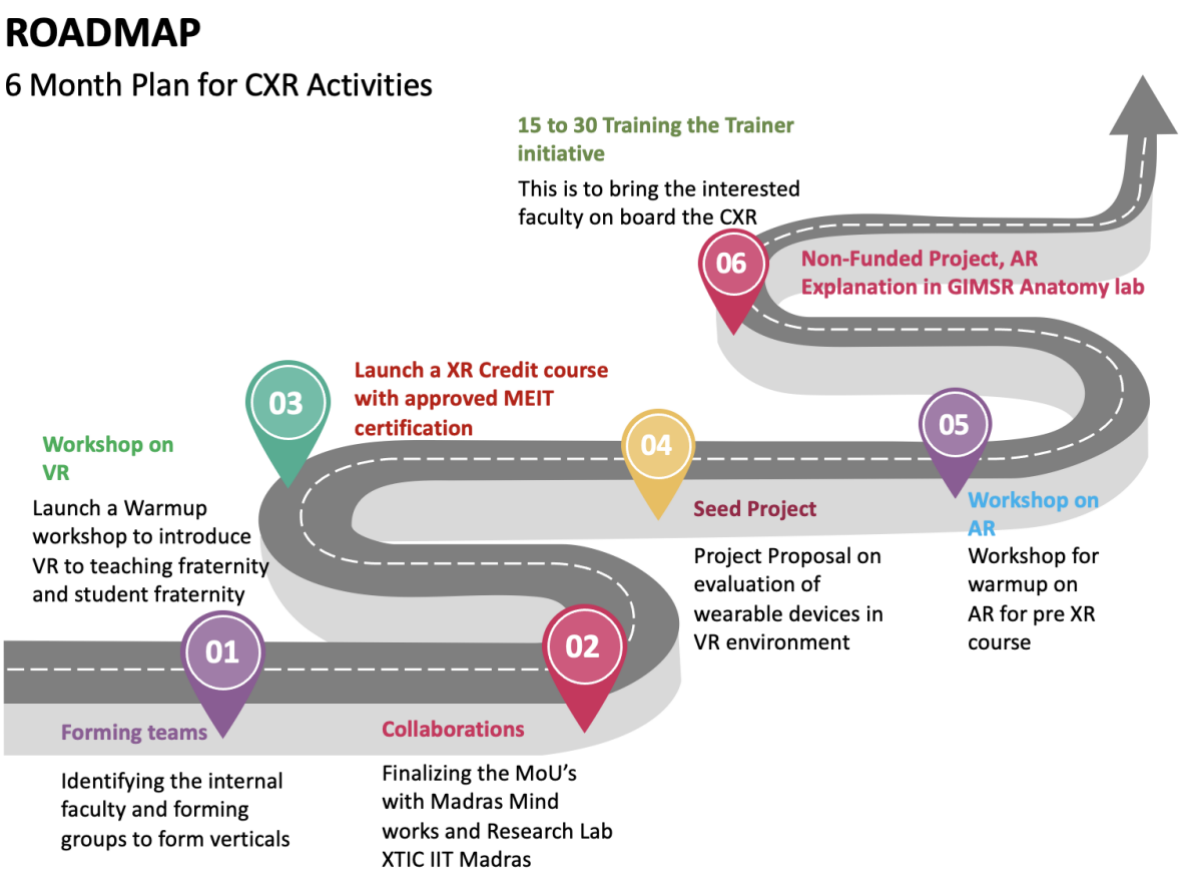



*Figure 6: Monthly Activity Planning for 6 Months (Tentative)*

## 3. Proposed Equipment

| S.No. | Equipment | Quantity | Purpose | Work Area |
|---|---|---|---|---|
| 1 | VR- HMD Occulus Quest or Pico Neo 2 Head set | 30 | VR and AR workshops, Practical course Carriculum, Projects | Tracking (AR and VR) Perception (AR and VR) |
| 2 | Microsoft Holo Lens | 1 | Mixed Reality Scenario design and development. | Mixed reality – (AR +VR) |
| 3 | Touch and Haptic Data glove | 2 | Getting feed back from virtual objects, applied in the proposed seed project | UI Interaction Immersion Remote Presence<br><br>(Touch and Haptics) |
| 4 | 360 Degree Camera | 1 | Used to record the real | Graphic Realism – (AR and VR) |

| | | | | |
|---|---|---|---|---|
| | | | surrounding and render for VR | |
| **5** | Precision 3650 DELL workstations | 30 | CUDA enable Graphic card to design VR and AR scenarios | All areas of (AR, VR and haptics) |
| **6** | IMac | 2 | Augmented Reality kit in MacOS helps to develop AR apps that are ready for launch. | Occlusion Detection Tracking Perception<br><br>(AR and VR) |
| **7** | Leap Motion Sensors | 30 | Hand guesture recognition | Interaction Tracking (AR and VR) |
| **8** | 3D Scanner | 1 | Scanning the real world objects to render as virtual objects | Graphic Realism<br><br>(AR and VR) |
| **9** | Unity Education Edition (free) | 1 | Designing Graphic content | |
| **9** | UV Sanitizer box | 1 | Hygiene | Health |

Table 1: Proposed equipment and purposes

# 4. **Current equipment**

| **S.No.** | **Equipment** | **Quantity** | **Purpose** | **Work Area** |
|---|---|---|---|---|
| **1** | Occulus Go<br><br>(obsolete) | 10 | VR and AR workshops, Practical course Carriculum, Projects | Tracking (AR and VR) Perception (AR and VR) |
| **2** | Dell Tower Workstations 32 GB RAM, 8 GB GPU, 1TB SSD | 20 | CUDA enable Graphic card to design VR and AR scenarios | All areas of (AR, VR and haptics) |
| **3** | Unity Education Edition | 1 | Designing Graphic content | All areas of (AR and VR) |
| **4** | Meshroom<br><br>(open source and free) | 1 | Meshing realworld objects, alternate to 3D scanning but with constraints. | |
| **5** | Blender (free) | 1 | Rendering realworld to virtual objects | |

Table 2: Current Equipment and purpose

# 5. Conclusion

CXR has a very ambitious objective to become a Research & Innovation powerhouse in the Extended Reality Area which includes AR, VR and MR. To this end, we have developed the above draft strategic plan for the Centre.

By providing world-class research facilities that include AR, VR equipment, along with the necessary support services to bring research ideas to market, CXR will ensure that there is smooth, seamless operation across the entire Continuum.

## 5.1. Role of CXR in GITAM

Among the many benefits we expect CXR to bring to GITAM University, here are a few important ones

- CXR research and innovation focus will allow interdisciplinary collaboration for new ideas to evolve in both hardware and software side of AR and VR. This will ultimately lead to CXR and GITAM to the leading edge of research and innovation in the field of Extended Reality.

- CXR will be a training environment for GITAM's students and researchers. As an integral part of the University, CXR will attract top-class students and researchers who can utilize world-class facilities like the AR VR equipment and High performance computing

- In long run CXR will use the best student and faculty experts to provide research services to internal and external clients, through its Business Development Division.

- CXR encourages New student initiatives and innovations, and acts as launch pad for start-up ideas through collaboration with VDC, GITAM

- CXR will also participate in developing contemporary, relevant education courses to enhance the University curriculum.

In summary, CXR will also provide an excellent environment for training GITAM's students, scholars and faculty and help develop GITAM as a premier R & I Institution in the world.