UNC Charlotte – Lee College of Engineering Senior Design Program
<u>Company Information</u>

Company Name	Electrical and Computer Engineering	Date Submitted	*11/7/19*
Project Title	Real-time Object Detection and Localization using Optical-See-Through Mixed Reality Glass **(UNCC_GLASS)**	**Planned Starting Semester**	Spring 2020

Funding:

What is the source of funds that will be used to cover all of the direct costs of this project?

Dr. Tao Han's research grants.

Is this source of funds already secured?   Yes <u>   x   </u>   No <u>   </u>

Technical Contact(s)*

	Technical Contact 1	**Technical Contact 2**	**Technical Contact 3**
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*We would like to have more than one technical contact, so there is a back-up in case of travel, sickness, job re-assignment, etc.

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	0	Electrical	3
Computer	1	Systems	0

Project Overview and Requirements:

Mixed Reality (MR) is a significant advancement of augmented reality (AR) which can provide the user interactive experience with the real world by using virtual objects. It is estimated that the global annual sales of head-mount AR or MR devices will reach 9982.8 million dollars by 2023, with the additional content services and enterprise-level applications, the market capacity can exceed 40 billion dollars. With high market demand promise, many technology companies have already joined in the research and development of MR and AR equipment and content which energize the MR area.

In this project, a networked Mixed Reality system will be developed together to enable real-time detection and localization. At a high level, this system has two main parts connected: A Mixed Reality device that can "understand" the user's environment and a cloud server running detection models that can provide user the objects detection service. For example, a user with a mixed reality device which can detect the object in the real world, e.g. a Red Cup. The system will tell the user the name of the object (Cup) and put a virtual marker on the real object. Different from the Augmented Reality (AR) system, the virtual marker will be exactly placed on the object. This means that no matter how the user moves, the position of the virtual marker will not change. In this project, the students will learn a wide range of new knowledge including networked system design, communication protocols, machine-learning frameworks, localization methods of MR device and mobile mixed reality application development.

The total cost of the project is about $7000.

Project Requirements:

The MR detection and localization system that will be developed in the project is illustrated in the

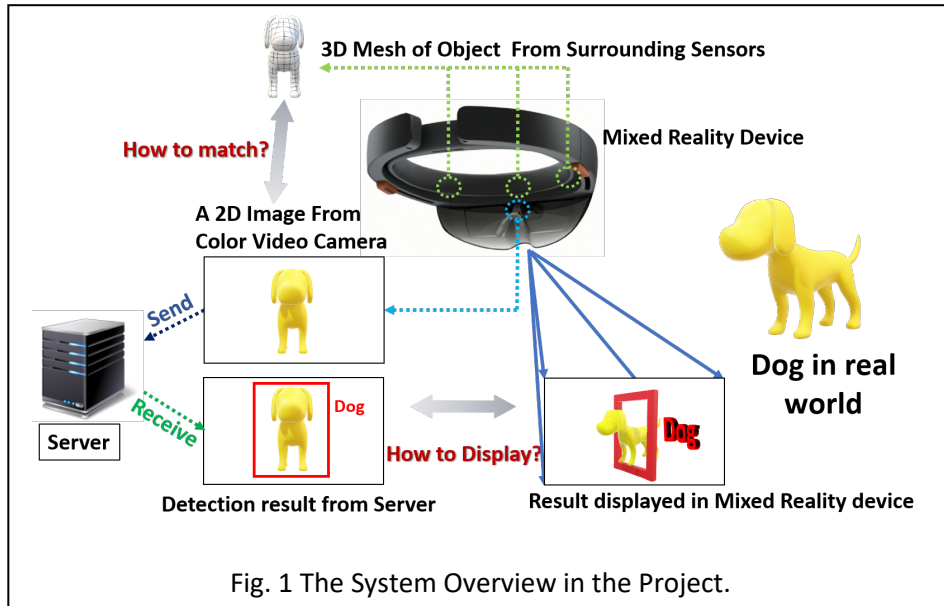Fig. 1 The System Overview in the Project.

Figure 1. The network MR device will be emulated by Microsoft HoloLens. The Server is an HPC which is equipped with an Intel i9 9900K CPU and three RTX 2070 Graphic Cards. In this system, the server provides the service of analyzing the 2D RGB images captured by HoloLens and sending the results back to HoloLens. The MR device will enable the user to sense the environment, collect 2D RGB data of the object and localize the object base on the result from the server in real-time. The system will rely on new networking protocols and computer vision and machine learning algorithms.

Specific Requirements:

1. The students who oversee different parts of the MR system should learn the corresponding skills to build the system. The skills including building software using Unity and DirectX. detecting objects using Machine Learning algorithm and basic knowledge of 3D construction. Note that students will be assigned specific tasks and learn one of the skills (do not have to learn all the skills).
2. Complete the application development in Microsoft HoloLens in which the application can allow the user to scan the environment and capture Person View (PV) by using the camera of HoloLens or another camera.
3. Design a coordinate system to synchronize the position and the object need to be detected. The basic function of the coordinate system is to build a 3D model of the environment and get the coordinate value for both users and detected objects.
4. Complete the object detection system on the server. The detection system includes the network interface for receiving and transmitting data, a machine learning algorithm to do object detection and a controller can control the trade-offs between speed and quality。
5. Complete the connection between HoloLens and Server for real-time data sharing and the connection can be controlled by a controller of the server.

Expected Deliverables/Results:

1. *A Mixed Reality (MR) system that can build a 3D model of the environment and place virtual content based on the given coordinates.*
2. *A server that can detect the image content and transmit the result.*
3. *A communication system that can allow the MR device and Server to share their data.*
4. *A system can detect and localize objects in the real world by using the MR device and server.*
5. *An adaptive control algorithm that can control the performance of the system based on the network environment.*

Disposition of Deliverables at the End of the Project:

The hardware developed in the project team will be placed in Mobile Networks and Systems at EPIC 2378.

List here any specific skills, requirements, knowledge needed or suggested (If none please state none):

Required
- Strong motivation to learn new knowledge
- Strong programming skills in C++ or C#
- Basic knowledge of computer networks and systems

Suggested (the following knowledge is desirable but can be developed during the project)

- Basic knowledge RGBD-SLAM.
- Basic knowledge of wireless communications and network
- Basic knowledge of Unity engine and DirectX.
- Basic knowledge of machine learning and computer vision