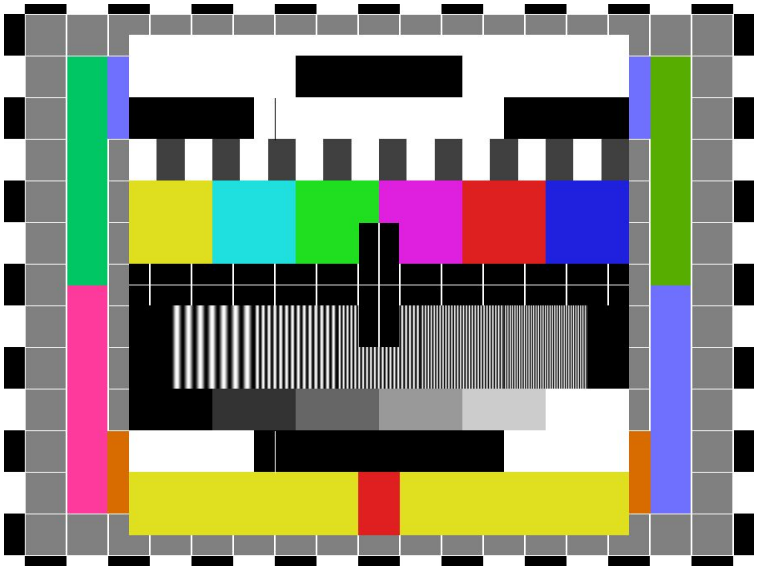
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
THE UNIVERSITY OF TEXAS AT ARLINGTON

SYSTEM REQUIREMENTS SPECIFICATION
CSE 4317: SENIOR DESIGN II
SPRING 2017



TEAM TELEPRESENCE
RIFT TELEPRESENCE

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Revision History

Revision	Date	Author(s)	Description
0.1	10.25.2016	CA, JG, AL, CO, TS	Document creation
0.2	04.17.2017	CA, JG, AL, CO, TS	Updated each requirements

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1 Product Concept

1.1 Purpose and Use

The Telepresence system should allow users to look around, using a virtual reality headset, in a location they would not otherwise be able to access.

1.2 Intended Audience

The anticipated audience for the Telepresence system ranges from mechanics to border patrol guards, anyone that would benefit from a set of eyes in conspicuous or hard-to-reach places can be assisted by our system.

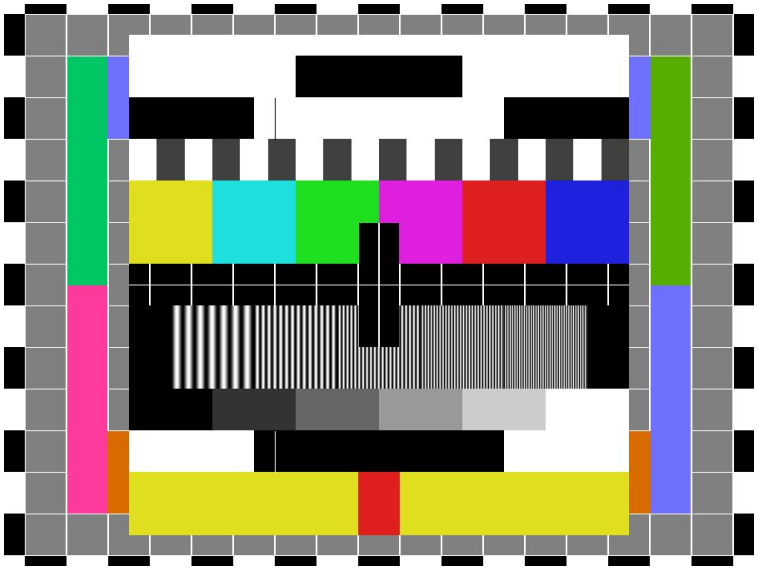

Figure 1: X conceptual drawing

2 Product Description

2.1 Features & Functions

The product will have a 3D range of visibility including camera pitch, yaw, and roll. It will be compact and low profile enough for most of its expected applications.

2.2 External Inputs & Outputs

- Raw video stream output from a dual/stereoscopic camera setup
- Inputs of head tracking coordinates from virtual reality headset

The product will stream raw video from cameras in a remote location to a virtual reality headset. The camera rig will grab the head tracking coordinates from the virtual reality headset to simulate the motion of the head. The camera rig is to be mounted at the head of a gimbal which is controlled directly by the virtual reality headset's accelerometer/gyro.

2.3 Product Interfaces

The virtual reality headset's built-in accelerometer will communicate with the system's gimbal to control the directive movements of the gimbal's motors by sending the raw angular data from the headset to the computer processing system. The Arduino board will receive the rotation signals from the processing system and translate the signals to their appropriate voltage steps to be sent to the motors. Also, the processing system will process the raw video stream input from the camera rig and transmit the video wirelessly to the virtual reality headset system.

3 Customer Requirements

3.1 The vehicle shall have a mounted gimbal

3.1.1 Description

The gimbal will offer each of the three major movement categories: pitch, roll, and yaw. The gimbal is to be designed by hand and utilize an individual servo motor for each directional category.

3.1.2 Source

CSE Senior Design project specifications.

3.1.3 Constraints

The area selected by the user must have adequate specifications to allow the camera system to be mounted.

3.1.4 Standards

None

3.1.5 Priority

Low Priority: The system will ultimately be mounted to an area of the user's choice.

3.2 The gimbal shall have a mounted stereoscopic camera setup

3.2.1 Description

The stereoscopic camera setup will be mounted at the apex of the gimbal's motors. The motors will allow the camera rig to encompass the maximum range of direction offered by a human neck.

3.2.2 Source

CSE Senior Design project specifications.

3.2.3 Constraints

The motors used in the design of the gimbal must be able to quickly and accurately adjust the camera setup.

3.2.4 Standards

None

3.2.5 Priority

High Priority: The gimbal must be able to adjust the camera setup according to the signals provided by the virtual reality headset.

3.3 The virtual reality headset's accelerometer/gyro shall control the gimbals movement

3.3.1 Description

The virtual reality headset's built-in accelerometer will be critical in directing the gimbal. Every motion detected by the headset will be translated and converted to individual signals appropriate to each servo motor. The goal is to simulate an encompassing sense of presence in the user.

3.3.2 Source

CSE Senior Design project specifications.

3.3.3 Constraints

The gimbal must be able to adjust the camera setup according to the signals provided by the virtual reality headset. The accelerometer's signals must be adequately translated to adjust the gimbal motors.

3.3.4 Standards

None

3.3.5 Priority

High Priority: The only alternative to headset-controlled movement is to implement a 360 degree camera which is generally outside of the project budget.

3.4 The stereoscopic camera shall stream live dual-panel video to the operating computer

3.4.1 Description

Each camera in the camera rig system will stream its synchronized video to a computer which is running virtualization software.

3.4.2 Source

CSE Senior Design project specifications.

3.4.3 Constraints

Live streaming high definition video may require hardware which is outside the project budget.

3.4.4 Standards

None

3.4.5 Priority

Low Priority: The video will output directly to a host computer until wireless video transmission can be reliably achieved.

3.5 The computer shall have software which streams the video from the camera rig to a virtual reality headset

3.5.1 Description

The video from the camera setup will initially be separate streams, each of which mimics and represents the visual input to each human eye. Virtualization software on the controlling PC will ensure the video is synchronized and render the video side-by-side to create an appropriate illusion of the dimensions. The video will be streamed through a wired connection to the virtual reality headset.

3.5.2 Source

CSE Senior Design project specifications.

3.5.3 Constraints

A computer which is capable of rendering video into a virtual reality headset format must be available to the user.

3.5.4 Standards

None

3.5.5 Priority

Low Priority: While the video will be rendered to a suitable format for a virtual reality headset, the headset itself may not be readily available for project development.

3.6 The system shall have a simple user interface

3.6.1 Description

While simple is ultimately a matter of end-user opinion, our goal is to simplify the system's interface as much as possible such that there are few to no discrepancies when it comes to system operation.

3.6.2 Source

CSE Senior Design project specifications.

3.6.3 Constraints

Some functionality which will be vital to system operation may not be known to the development team as of now. The degree of simplicity of the interface will depend on the completed list of functional requirements of the system at the time of delivery.

3.6.4 Standards

None

3.6.5 Priority

Low Priority: During development, the layout of the user interface may be scattered. The interface will be simplified only if all other specifications are met.

3.7 The system shall deliver 3D stereo display

3.7.1 Description

The purpose of the system is to take stereoscopic video input and stitch the streams together to render a virtual 3D environment. This environment is intended to be viewed through a virtual reality headset, and may also be rendered by high-end GPUs on any screen capable of 3D display.

3.7.2 Source

CSE Senior Design project specifications.

3.7.3 Constraints

The user must possess hardware capable of rendering a 3D environment. While the system will be tested using a virtual reality headset, the system will be delivered independent of any external visualization components. The developers assume that the target audience will need to obtain a virtual reality headset separately from the system.

3.7.4 Standards

None

3.7.5 Priority

High Priority: The camera rig will be designed for this purpose alone.

3.8 The system shall stream real-time video from a remote location

3.8.1 Description

The system will be mounted and will stream raw video output from the stereoscopic camera rig. The processing system takes the raw video stream from the camera system and displays the stream to the virtual reality headset. The processing system will be used to render the video in a 3D environment.

3.8.2 Source

CSE Senior Design project specifications.

3.8.3 Constraints

Many of the specific hardware components to be used by the system remain unknown. Budget requirements may restrict the quality of hardware used in the system, which in turn may lead to latency limitations which cannot be easily surpassed. In order to achieve this requirement, an agreeably low wireless video latency must first be achieved.

3.8.4 Standards

None

3.8.5 Priority

High Priority: In order for an agreeable virtual reality environment to be created, the video stream should be as close to real-time as possible.

3.9 The camera rig shall be light weight

3.9.1 Description

In order for the gimbal to reliably adjust the directive angle of the camera rig, the rig must be below a certain weight threshold.

3.9.2 Source

CSE Senior Design project specifications.

3.9.3 Constraints

The weight of the cameras used in the system will determine the minimum achievable weight of the camera rig. The weight of the camera rig will determine the rotational torque needed in gimbal motors.

3.9.4 Standards

None

3.9.5 Priority

Moderate Priority: A heavy camera rig may slow the movement of the gimbal and require more expensive hardware.

3.10 The system shall have a toggled lighting mechanism

3.10.1 Description

An LED system will be included at the front of the camera rig which can be toggled by the user. This will increase system utility as environmental observability is increased.

3.10.2 Source

CSE Senior Design project specifications.

3.10.3 Constraints

The LEDs must be low-weight and have low power consumption ratings. The LEDs must be operated remotely by a switch available to the user.

3.10.4 Standards

None

3.10.5 Priority

Low Priority: This requirement will only be implemented once all other specifications are met.

3.11 The camera rig shall be durable

3.11.1 Description

The mobility of the system demands limited system durability. The camera rig will be designed to operate normally under reasonable environmental conditions.

3.11.2 Source

CSE Senior Design project specifications.

3.11.3 Constraints

The durability of the camera rig depends on the independant durability of the cameras used in the design of the system.

3.11.4 Standards

None

3.11.5 Priority

Moderate Priority: The mobility of the system requires that the camera rig to be able to withstand certain external vibrations and forces.

3.12 The gimbal shall operate normally under low system vibration

3.12.1 Description

The mobility of the system will cause unavoidable system vibration that can cause nausea and discomfort to the end-user. In order to circumnavigate this effect, the gimbal shall be designed to provide a low level stabilization to reduce visual noise by system vibration.

3.12.2 Source

CSE Senior Design project specifications.

3.12.3 Constraints

The environment traversed by the system will directly affect the amount of vibrations delivered to the gimbal. Vehicular momentum will also affect system vibration.

3.12.4 Standards

None

3.12.5 Priority

Moderate Priority: While system mobility is a factor, most system development will be conducted under a stationary environment. The system shall, at least, compensate for self-induced vibrations from the gimbal.

3.13 The system shall run on a removable battery pack

3.13.1 Description

The system's power supply will be interchangeable to maximize system utility. Rather than utilizing a station which recharges an internal battery, the user will be able to easily remove and replace the systems power supply.

3.13.2 Source

CSE Senior Design project specifications.

3.13.3 Constraints

The battery pack must be lightweight. The components used by the system will determine the power rating of the supply chosen to run the system. The battery pack used by the system may or may not be rechargeable.

3.13.4 Standards

None

3.13.5 Priority

High Priority: The camera rig and gimbal must be mobile. Connection to an external power source would limit the mobility of the system. The power delivered to the system will be easily changeable ideally. Budget constraints may affect this requirement.

4 Packaging Requirements

4.1 The camera rig shall have software preloaded

4.1.1 Description

The system will be delivered in a video-ready state. No adjustments will need to be made to the camera rig in order to achieve the stated video specifications. The camera rig will be ready after being mounted onto the gimbal.

4.1.2 Source

CSE Senior Design project specifications

4.1.3 Constraints

Camera settings do not need calibration with each startup. Cameras do not auto focus, but maintain the specified focal point between systems. Virtual reality directive software calibrates camera frame rates.

4.1.4 Standards

None

4.1.5 Priority

High Priority: Essential to user-friendly operation of the target system.

4.2 The camera rig shall come pre-assembled

4.2.1 Description

The user will not have to align the cameras. The only physical setup necessary will be a simple mounting of the cameras onto the gimbal.

4.2.2 Source

CSE Senior Design project specifications

4.2.3 Constraints

The cameras used in production are to be mounted to a single board rather than mounted individually.

4.2.4 Standards

The camera mount will be stable enough to support both cameras and ensure that no position variation is allowed.

4.2.5 Priority

High Priority: The user will not have to buy and build the components for the camera rig.

4.3 Virtual reality software shall be installed on-site

4.3.1 Description

The user will install the virtual reality software on their computer.

4.3.2 Source

CSE Senior Design project specifications

4.3.3 Constraints

The user must have a computer with the required specifications

4.3.4 Standards

None

4.3.5 Priority

High Priority: The user must have the virtual reality software installed on their computer to use the camera device.

4.4 Virtual reality rig shall be assembled on-site

4.4.1 Description

It is the users responsibility to have a virtual reality headset that is configured and ready for use.

4.4.2 Source

CSE Senior Design project specifications

4.4.3 Constraints

The user must have a computer capable of supporting a virtual reality headset.

4.4.4 Standards

None

4.4.5 Priority

High Priority: Without a virtual reality headset, the camera device will not function as intended.

5 Performance Requirements

5.1 Operating time for the camera rig shall have a minimum of one hour of battery life

5.1.1 Description

All the individual components of the camera rig and the amount of data to be transferred will take most of the power from the camera rig. The goal of the camera rig is to send a clear video feed from a location back to the virtual reality headset. So, a battery life of a minimum of one hour will be plenty for this project.

5.1.2 Source

CSE Senior Design project specification

5.1.3 Constraints

The size of the camera rig will have an impact on the amount of power needed to operate the camera rig.

5.1.4 Standards

None

5.1.5 Priority

Critical Priority: Without a decent amount of battery power, the camera rig will not operate as intended or be inoperable.

5.2 Video latency shall be under 50ms

5.2.1 Description

The video being streamed from the camera device to the virtual reality headset must be delivered within a 50 millisecond timeframe.

5.2.2 Source

CSE Senior Design project specification

5.2.3 Constraints

Budgetary constraints may result in hardware with some latency.

5.2.4 Standards

None

5.2.5 Priority

Moderate Priority: User comfort is somewhat reliant on the latency of the video.

5.3 Video shall have 60 frames per second video rendering

5.3.1 Description

In order for the video to be believable, minimum video specifications must be met. Based on developer opinions and video enthusiast message boards, the minimum agreed upon specifications are 720p at 30fps. The group believes that these specs are more than achievable, and aims to produce a product that delivers a reliable 1080p at 60fps.

5.3.2 Source

CSE Senior Design project specification

5.3.3 Constraints

Budget constraints may limit the capabilities of the components available during development.

5.3.4 Standards

None

5.3.5 Priority

High Priority: To experience virtual reality in real-time, rendering high quality video is important.

5.4 Video shall be stable when camera rig is in motion up to 5 MPH

5.4.1 Description

The video feed from the camera rig to the virtual reality headset should be stable when the camera rig is in motion of no more than 5 miles per hour. The operation of the camera rig is not meant to be used under extreme conditions regarding to speed because of the amount of data that has to be transferred to the virtual reality headset.

5.4.2 Source

CSE Senior Design project specification

5.4.3 Constraints

The type of algorithm used will affect the video feed.

5.4.4 Standards

None

5.4.5 Priority

High Priority: If the camera rig is moving higher than 5 mph, video feed will be unstable, and it will possibly crash.

5.5 The camera rig shall have a maximum translation error of 0.5 degrees

5.5.1 Description

The camera rig will match the user's head movement to a tolerance of 0.5 degrees.

5.5.2 Source

CSE Senior Design project specification

5.5.3 Constraints

Software and hardware capabilities may affect the translation error.

5.5.4 Standards

None

5.5.5 Priority

Moderate Priority: One-to-one movement between the camera device and the user's virtual reality headset makes a massive difference in the user's experience with the device.

6 Safety Requirements

6.1 The user shall discontinue using the product when experiencing symptoms of sickness

6.1.1 Description

If the user is experiencing any type of nausea, dizziness, sweating, or disorientation while using the product, usage of the product must be stopped immediately. If symptoms persist after continued use, visiting a doctor is recommended to check if continuing usage of the product is safe.

6.1.2 Source

CSE Senior Design project specifications

6.1.3 Constraints

None

6.1.4 Standards

None

6.1.5 Priority

High Priority

6.2 The user shall use the product in an open environment

6.2.1 Description

The product is best used in an environment with very few obstructions to the users head. Obstructions that can impede the user such as cabinets or shelves are an example. Standing or sitting in one spot is the intended use of the product to ensure safety to the user.

6.2.2 Source

CSE Senior Design project specifications

6.2.3 Constraints

None

6.2.4 Standards

None

6.2.5 Priority

Moderate Priority

6.3 Camera rig shall have battery shield to prevent damage

6.3.1 Description

The battery of the camera rig will be enclosed with extra layers or a special layer of hardware, a battery shield, to protect from unexpected explosions. This will minimize the damage that the battery can cause to the surrounding area.

6.3.2 Source

CSE Senior Design project specifications

6.3.3 Constraints

Budget constraints may limit the hardware needed.

6.3.4 Standards

None

6.3.5 Priority

Low Priority: AA batteries are being used, so the expectation of an explosion is highly unlikely.

6.4 The cables of the camera rig shall be secured to prevent wire tangling and shorts

6.4.1 Description

Cables connecting components of the device must be stowed in an orderly manner to avoid snags and possibly, electrical malfunctions.

6.4.2 Source

CSE Senior Design project specifications

6.4.3 Constraints

None

6.4.4 Standards

None

6.4.5 Priority

Low Priority: While not having tangled wires is preferable, this is not a critical requirement for the functionality of the device.

7 Maintenance & Support Requirements

7.1 Parts list will come with the product

7.1.1 Description

System components: Stereoscopic camera rig, gimbal, arduino microcomputer, NUC barebones computer, battery pack External components: Computer (minimum hardware requirements), virtual reality headset

7.1.2 Source

CSE Senior Design project specifications.

7.1.3 Constraints

None

7.1.4 Standards

None

7.1.5 Priority

Low Priority

7.2 Assembly instructions shall come with the product

7.2.1 Description

The user should be able to assemble the device using a comprehensive instruction manual.

7.2.2 Source

CSE Senior Design project specification.

7.2.3 Constraints

None

7.2.4 Standards

None

7.2.5 Priority

Moderate Priority: The user having good instructions to follow, is important to minimizing the startup time for the user.

7.3 Camera rig servicing instructions will come with the product

7.3.1 Description

The user will receive instructions detailing how to make adjustments to parts of the camera rig that need to be replaced or fixed.

7.3.2 Source

CSE Senior Design project specification

7.3.3 Constraints

None

7.3.4 Standards

None

7.3.5 Priority

Low Priority: While useful, this requirement is not required for normal operation of the device and is more of a bonus support item.

7.4 User manual shall come with the product

7.4.1 Description

The user manual is a comprehensive document detailing product specifications, product startup, and product use.

7.4.2 Source

CSE Senior Design project specification.

7.4.3 Constraints

None

7.4.4 Standards

None

7.4.5 Priority

High Priority: A user manual is an expected and necessary document that allows a user to understand the product both conceptually and behaviorally.

7.5 Modular construction

7.5.1 Description

The device will be constructed in a modular way that supports easy part removal and replacement.

7.5.2 Source

CSE Senior Design project specification.

7.5.3 Constraints

None

7.5.4 Standards

None

7.5.5 Priority

Low Priority: This is not necessary for the device to function or be useful, instead it is a design goal and will be useful for device maintenance.

8 Other Requirements

No other requirements are known to the development team at this time.

9 Future Items

9.1 Upgraded video capabilities

9.1.1 Description

The ideal video capabilities utilized by the system are 2160p (or greater) at 60+fps.

9.1.2 Source

HTC Vive

9.1.3 Constraints

These conditions are not currently achievable without high-end hardware components, each of which may run multiple times beyond our system budget.

9.1.4 Standards

The modern virtual reality standard operates ideally at 2160p with a 90Hz refresh rate. These headsets are first-generation models, and future models are expected to extend hardware capabilities exponentially. In order to achieve these standards, extremely low latency must be achieved wirelessly while transmitting and processing gigabytes of data over the air.

9.1.5 Priority

Future Priority