Department of Computer Science & Engineering
The University of Texas at Arlington

# Architectural Design 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 | 12.15.2016 | CA, JG, AL, CO, TS | Removed Mobile Platform Layer |
| 0.3 | 04.19.2017 | CA, JG, AL, CO, TS | Update document |

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# 1 INTRODUCTION

The project will be a custom stereoscopic camera mounted on a gimbal with 3D movement capabilites (pitch, yaw, roll). The movement of the cameras will be one-to-one with the movement of a virtual reality headset on the user. Minimal computation will be used onboard the actual unit. The majority of processing will be accomplished by the computer running the virtual reality headset. Camera focal points will be preset and calibrated to predetermine the focal distance. Initial versions of the system will use a wire tether for data transfer between the camera unit and processing unit.

## 2 System Overview

The overall structure of the software system contains three layers: Camera System, Processing System, and Virtual Reality System. The Camera System is the physical hardware to get the raw video stream to transfer in the system. Also, the Camera System contains a gimbal subsystem to allow it to record video in a way that simulates the motion of a head. To make it possible to transfer the video feed across the system, the Processing System performs the necessary tasks to transfer it to the Virtual Reality System. The Virtual Reality System and the Processing System also communicate with each other in order to get the necessary head tracking angles to send to the Camera System for the gimbal subsystem.

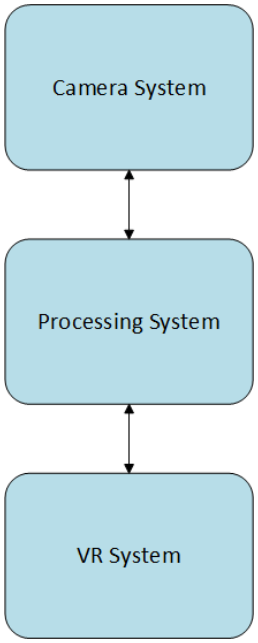


Figure 1: Overall structure of system

### 2.1 Camera System Layer Description

The Camera System contains a camera subsystem, a gimbal subsystem, and a gimbal controller subsystem. The raw video stream taken from this system will be sent to the Processing System to be processed. To get the expected results from this system, the head tracking angles sent from the Processing System will be processed for this system's gimbal to read and perform accordingly.

### 2.2 Processing System Layer Description

This system contains the video input subsystem, the video output subsystem, and the gimbal controller subsystem. Raw video data will be received from the Camera System, processed, and transferred to the Virtual Reality System. In return, this system will take head tracking angles from the Virtual Reality System and send it to the Camera System through serial communication.

### 2.3 Virtual Reality System Layer Description

The Virtual Reality System is focused on delivering real-time video and tracking of the head movement on the virtual reality headset. This system contains the stereo display subsystem and the head tracking subsystem. The processed video data sent from the Processing System will be displayed in this system. At the same time, raw head tracking angles are taken from this system's headset and sent to the Processing System.

# 3 Subsystem Definitions & Data Flow

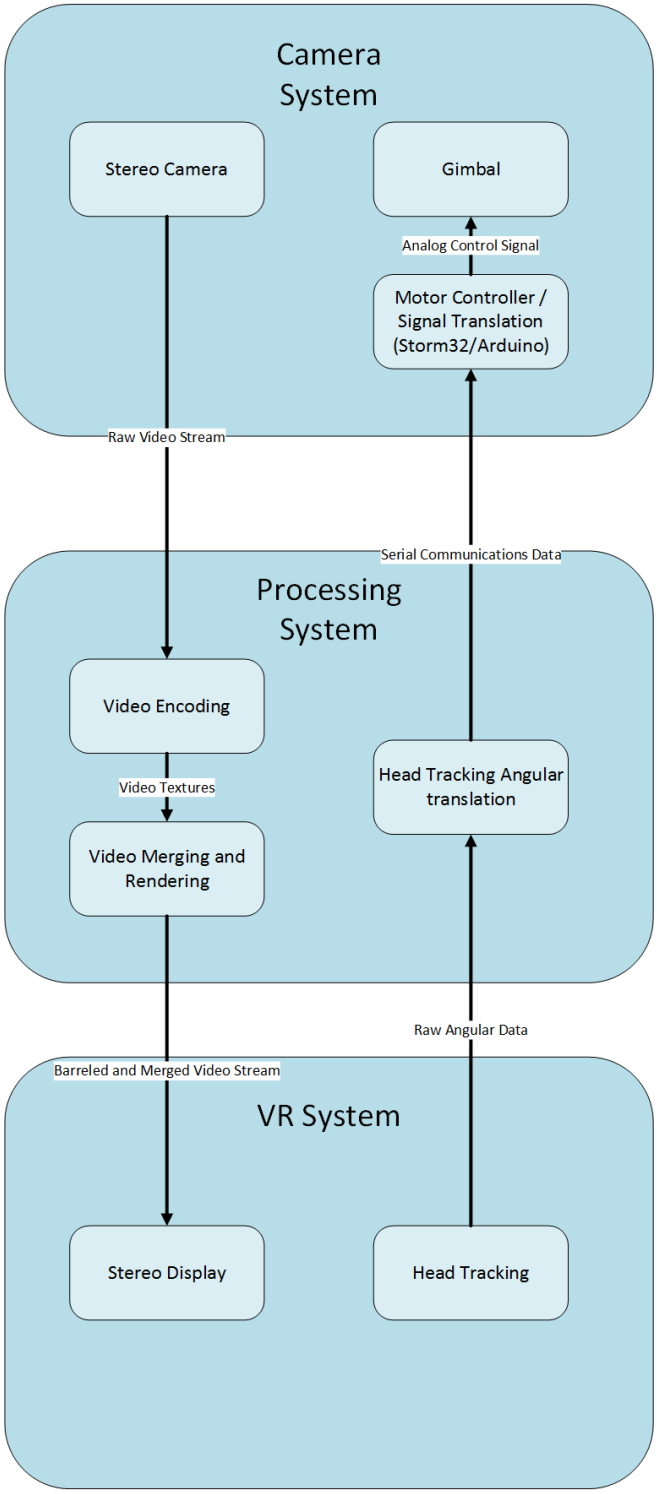


Figure 2: Data flow diagram of system

# 4 Camera System Layer Subsystems

The Camera System Layer contains a camera subsystem, gimbal subsystem, and gimbal controller subsystem. These subsystems send raw video streams to the Processing System Layer and receive head tracking angles from it.

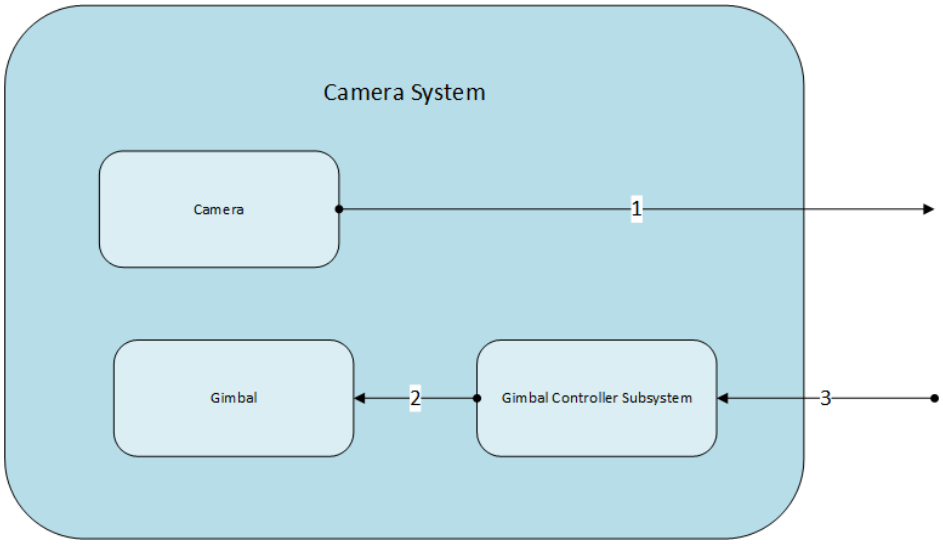


Figure 3: Camera System Layer Subsystem Description Diagram

## 4.1 Camera Subsystem

The camera subsystem will send the raw video streams directly to the Processing System to be processed.

### 4.1.1 Assumptions

This subsystem is assumed to be handled by the firmware already built into the cameras.

### 4.1.2 Responsibilities

This subsystem is responsible for giving video input to the system that will eventually end up in the virtual reality headset the user is wearing.

### 4.1.3 Subsystem Interfaces

This subsystem will have a one-way interface which is with the Processing System's video input subsystem. Through this interface, the raw video will be streamed and processed.

Table 2: Camera Subsystem interfaces

| ID | Description | Inputs | Outputs |
|---|---|---|---|
| #1 | Processing System - Video Input Subsystem | N/A | Raw video footage |

## 4.2 Gimbal Subsystem

This subsystem communicates with the gimbal controller subsystem to move each gimbal motor to their position.

### 4.2.1 Assumptions

Head tracking angles are read in a certain order from the translations of angles from the gimbal controller subsystem's serial communication.

### 4.2.2 Responsibilities

This subsystem is responsible for the movement of the gimbals by reading and moving into the positions given by the gimbal controller subsystem's head tracking angles.

### 4.2.3 Subsystem Interfaces

This subsystem will have a one-way interface. Head tracking angles are received from the gimbal controller subsystem.

Table 3: Gimbal Subsystem interfaces

| ID | Description | Inputs | Outputs |
|---|---|---|---|
| #2 | Gimbal Controller Subsystem | Translated head tracking angles | N/A |

## 4.3 Gimbal Controller Subsystem

Head tracking data will be received and handled in this subsystem from the Processing System before sending the resulting data to the gimbal subsystem.

### 4.3.1 Assumptions

None

### 4.3.2 Responsibilities

This subsystem will receive the head tracking angles from the Processing System. It will then translate the angles to be sent to the gimbal subsystem.

### 4.3.3 Subsystem Interfaces

This subsystem will have two one-way interface. The Processing system will send the data to this subsystem which will then send it to the gimbal subsystem.

Table 4: Gimbal Controller Subsystem interfaces

| ID | Description | Inputs | Outputs |
|---|---|---|---|
| #3 | Gimbal Subsystem | N/A | Translated head tracking angles |
| #4 | Processing System - Gimbal Controller Subsystem | Head tracking angles | N/A |

# 5 Processing System Layer Subsystems

This system contains the video input subsystem, the video output subsystem, and the gimbal controller subsystem. Each subsystem makes it possible for this system to communicate with the Camera System Layer and the Virtual Reality System Layer. Video data will be received from the Camera System Layer and transferred to the Virtual Reality System Layer, while angular data will be received from the Virtual Reality System Layer and sent to the Camera System Layer.

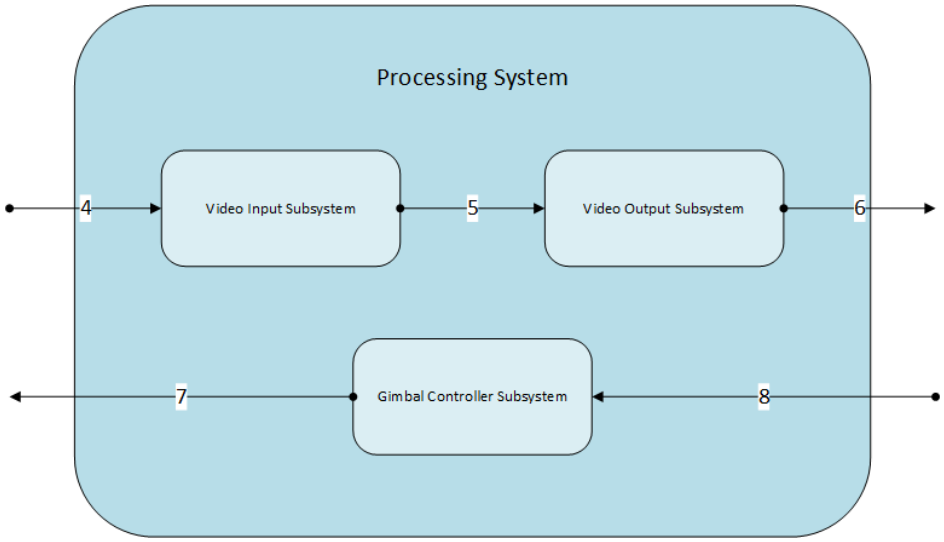


Figure 4: Microcomputer System Layer Subsystem Description Diagram

## 5.1 Video Input Subsystem

This subsystem communicates with the camera subsystem in the Camera System Layer. Also, the video interface subsystem interacts with the video output subsystem in this system.

### 5.1.1 Assumptions

None

### 5.1.2 Responsibilities

This subsystem will receive raw video data sent from the Camera System Layer. The raw video data will then be processed and sent to the video output subsystem in this system.

### 5.1.3 Subsystem Interfaces

Table 5: Video Input Subsystem interfaces

| ID | Description | Inputs | Outputs |
|---|---|---|---|
| #5 | Camera System - Camera Subsystem | Raw video data | N/A |
| #6 | Video Output Subsystem | N/A | Processed video data |

## 5.2 Video Output Subsystem

This subsystem interacts with the video input subsystem in this system, and it will be one of the means of communication between the Processing System Layer and the Virtual Reality System Layer.

### 5.2.1 Assumptions

None

### 5.2.2 Responsibilities

Processed video data is received from the video input subsystem in this system. With the video data, it will be transferred to the Virtual Reality System Layer to be displayed.

### 5.2.3 Subsystem Interfaces

Table 6: Video Output Subsystem interfaces

| ID | Description | Inputs | Outputs |
|---|---|---|---|
| #7 | Video Input Subsystem | Processed video data | N/A |
| #8 | Virtual Reality System - Stereo Display Subsystem | N/A | Processed video data |

## 5.3 Gimbal Controller Subsystem

This subsystem interacts with the gimbal controller subsystem of the Camera System Layer and the head tracking subsystem of the Virtual Reality System Layer.

### 5.3.1 Assumptions

None

### 5.3.2 Responsibilities

This subsystem will take the raw angular data taken from the virtual reality headset of the Virtual Reality System Layer and send it to the gimbal controller subsystem of the Camera System Layer through serial communication.

### 5.3.3 Subsystem Interfaces

Table 7: Gimbal Controller Subsystem interfaces

| ID | Description | Inputs | Outputs |
|---|---|---|---|
| #9 | Camera System - Gimbal Controller Subsystem | N/A | Head tracking angles |
| #10 | Virtual Reality System - Stereo Display Subsystem | Raw head tracking angles | N/A |

# 6 Virtual Reality System Layer Subsystems

The Virtual Reality System Layer is focused on delivering real-time video and tracking of the head movement on the virtual reality headset. This system contains the stereo display subsystem and the head tracking subsystem. Both of the subsystems make it possible to communicate with the Processing System Layer.

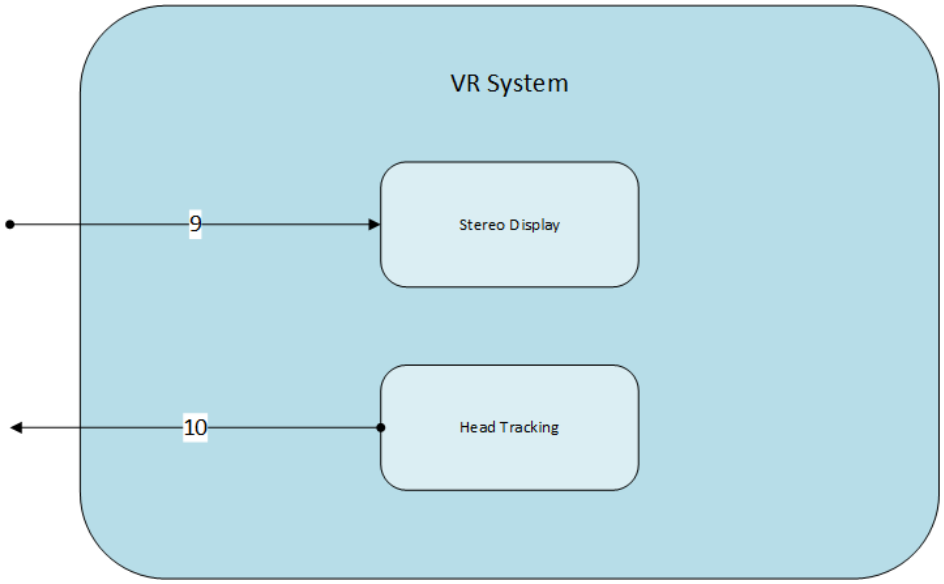


Figure 5: Virtual Reality System Layer Subsystem Description Diagram

## 6.1 Stereo Display Subsystem

This subsystem interacts with the video output subsystem of the Processing System Layer by receiving the processed video data.

### 6.1.1 Assumptions

None

### 6.1.2 Responsibilities

The processed video data received from the Processing System Layer will be displayed through the user's virtual reality headset.

### 6.1.3 Subsystem Interfaces

Table 8: Stereo Display Subsystem interfaces

| ID | Description | Inputs | Outputs |
|---|---|---|---|
| #11 | Processing System - Video Output Subsystem | Processed video data | N/A |

## 6.2 Head Tracking Subsystem

This subsystem interacts with the gimbal controller subsystem of the Processing System Layer by sending head tracking data.

### 6.2.1 Assumptions

The accelerometer signals can be extracted from the headset. The accelerometer signals extracted from the headset can be decoded into standard PWM signals to control motor movement.

### 6.2.2 Responsibilities

Head tracking angles are taken from the user's virtual reality headset. The raw angular data will be sent to the gimbal controller subsystem of the Processing System Layer.

### 6.2.3 Subsystem Interfaces

Table 9: Head Tracking Subsystem interfaces

| ID | Description | Inputs | Outputs |
|---|---|---|---|
| #12 | Processing System - Gimbal Controller Subsystem | N/A | Raw head tracking angles |