Method of Validation

Target testing can be accomplished by running the prototype and ensuring each function is operating. Functionality such as transport, mapping, and motion sense can be measured simply by their metric. The volume refers to the space the device will be able to be transported in and will be measured in real-time when designing, while mapping and motion sensing are inherent to the tablet display and position. Testing motion consists of rotating the device and viewing the action that rotation will cause within the virtual space. Through the use of markers in the virtual space and consistent rotation, the motion of the iPad will be directly compared to the position shown in the virtual world. Testing on the mapping functions will be approached in a similar manner. The functionality of various tasks can be tested by the use of the device as a whole essentially ensuring that each task operates as intended. This means that the record button should successfully start/stop recording, the lens should be switchable, and so on. To test the user's ability to comprehend the device, the prototype will be demoed by film students who will be able to provide feedback. From this feedback, an average learning curve can be deducted.

Determination of Targets

These targets were determined by the customer needs and research of market trends in camera production. This project is designed to be used by traditional cinematographers. To better understand their needs a meeting was conducted to understand the functions of a traditional film production camera and what functions can be applied to a tactile virtual camera controller. The most important needs were identified with the input of several cinematography students and their professors.

Primary Targets

Function	Metric	Target
Transport the Camera	Volume (ft^3)	1.5
Position in the Virtual World	Can the controller navigate throughout the entire scope of the 3D world?	Yes
Visualize	Does the iPad correctly mirror what was produced in Unreal Engine?	Yes
Map in 3D	Area Ratio	1:1

Perform Several Tasks	Are there multiple features?	Record, footprint, camera placement, lens, playback
Motion Sense	Angle Ratio (degree)	1:1
Comprehend Tasks	Length of time to learn tasks (hours)	5
Range	Range of communication between the device and Unreal Engine (feet)	30

Beyond functions

In addition to our original functions from the functional decomposition, we discussed other elements that might be necessary for our project. Once they were decided on, we moved on to creating targets for them. For latency between Unreal Engine (UE4) and the iPad/widgets, time was the best measure that could be used because the connect from the software to the hardware will have a delay. Knowing that there is a delay, the target for it was not more than 100 ms. The lighting function will be measured in lumens. The target for this is to be able to connect the full range present display that is used with unreal engine to the display of the iPad smoothly. The decision for the target for the camera lens function came directly from working with students who will be testing the product. A base len size will be used in the initial testing of the product, but all the different lens sizes, measured in mm, are an end goal that will be achieved by the camera. When it came to the weight function, the target was determined by the want of a lightweight product that also encompasses all the hardware needed to complete the main goal.

Function	Metric	Target
Latency between Unreal, iPad and widgets	Time (ms)	67-100
Lighting	Lumens	Full range present in UE4
	Does the lighting display on an iPad screen?	Yes
Camera Lens Function	Lens options (mm)	18, 25, 35, 50, 75, 100

Weight	Pounds (lb)	<10

Method of Validation for Additional Functionality

When testing for latency, the device will simply have to operate and be timed on the length of each process. This includes the time between information received and processes between the machine running UE4 and the device along with the timing between the use of the physical widgets and the feedback on the device. Lighting will be dependent on the device's ability to manipulate the settings on UE4 so this test will simply ensure that the I/O interface between these two points operates correctly. This is similar to Lens, where these options will be present in the software of UE4 and the device must have effective access to manipulate this setting. Weight will be measurable in real time as the designs for the portable device are created using data on parts being used.

Critical Targets

Critical targets are defined as those that without completeness the device will not function. For example, camera lense function, weight, and efficient latency, are all key metrics, however without them, the camera controller will still operate. On the other hand, if the controller is unable to define 3D mapping, the controller is useless. The critical functions for this device are, positioning in a virtual world, 3D mapping, and visualising. When the controller is coupled with Unreal Engine it must define the entirety of the free space, understand the positioning within it, and relay that information to the user.

When a virtual space is created, it is based off of scaling and multiple planes. Being able to map the space takes the input of the x, y, and z-axis, along with depth perception. The coordinates of where the user is within the world in terms of axis or plane determines the shot. If the scaling is 100:1 from actual to virtual, the user could pan over a virtual city, meanwhile a 1:1 would be critical for eye level shots. In order to move around the set, the controller must first understand its location of origin.

As the user moves the controller and camera, it creates multiple vectors, based off the speed and direction of motion. The system relays the path from the iPad to the main computer. By preventing the use of certain axis or planes, features of the camera can become possible. By locking the two axises, a track or dolly effect can be created and by locking one, a rotational or directional dolly can be made. In order to capture the virtual world it is necessary to map it.

Even being able to understand location, virtual space, and movement within the device, without a relay to the user, the prenotated functions can not be utilized. The visual feedback to the user provides the physical interface between the Unreal Engine and the user. This interface is what makes all other functions valuable. For an absence of visualization, lenses, lighting, and camera movement become useless.

Discussion of Measurements

The resources that will be needed to validate our design will include various measurement devices and sensors to measure both physical and software aspects. The physical measurements of the device will be based off of industry standards and what our users feedback pertaining to the topic was. To provide Unreal Engine 4 with the necessary data, sensors such as accelerometers x,y,and z-axis sensors, and pitch, roll, and yaw sensors will need to be measured in order to verify it is properly giving the user the correct information.. The accelerometer will allow our team to measure how quickly the user is moving and properly relate it to the Unreal Engine. The 3-axis sensor will relay the current position of where the user is in relation to the space and relay that information to Unreal engine. When it pertains to physical buttons, to ensure that buttons are properly working, we will utilize measurement devices such as multimeters to ensure enough power is being provided to the buttons and no damage is being dealt to the screen.