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Sample Code

Enhancing live video by leveraging TrueDepth camera data

Apply your own background to a live capture feed streamed from the front-facing TrueDepth camera.

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iOS 12.0+ | iPadOS 12.0+ | Xcode 16.0+

Overview

The TrueDepth camera provides real-time depth data that allows you to segment foreground from background in a video feed.

This sample app leverages depth data to dynamically replace the entire background with a custom image. It then performs Gaussian filtering and other image processing operations to remove holes and smooth the effect.

Preview the sample app

To see this sample app in action, build and run the project in Xcode on a device running iOS 11 or later. Because Xcode doesn't have access to the TrueDepth camera, this sample won't work in the Xcode simulator.

The sample app begins by removing the background, replacing it with black. Apply your own image from the camera roll by swiping down anywhere on the video feed.

Set up live capture from the TrueDepth camera

Set up an [AVCaptureSession](#) on a separate thread via the session queue. Initialize this session queue before configuring the camera for capture.

```
// Communicate with the session and other session objects on this queue.  
private let sessionQueue = DispatchQueue(label: "session queue", attributes: [], aut
```

The [startRunning\(\)](#) method is a blocking call which can take a long time. Dispatch session setup to the sessionQueue so the main queue isn't blocked, allowing the app's UI to stay responsive.

```
sessionQueue.async {  
    self.configureSession()  
}
```

Setting up the camera for video capture follows many of the same steps as normal video capture. See [Setting up a capture session](#) for details on configuring streaming setup.

On top of normal setup, request depth data by declaring a separate output:

```
private let depthDataOutput = AVCaptureDepthDataOutput()
```

Explicitly add this output type to your capture session:

```
if session.canAddOutput(depthDataOutput) {  
    session.addOutput(depthDataOutput)  
    depthDataOutput.isFilteringEnabled = true  
    if let connection = depthDataOutput.connection(with: .depthData) {  
        connection.isEnabled = true  
    } else {  
        print("No AVCaptureConnection")  
    }  
} else {  
    print("Could not add depth data output to the session")  
    setupResult = .configurationFailed  
    session.commitConfiguration()  
    return  
}
```

Search for the highest resolution available with floating-point depth values, and lock the configuration to the format.

```

let depthFormats = videoDevice.activeFormat.supportedDepthDataFormats
let depth32formats = depthFormats.filter({
    CMFormatDescriptionGetMediaSubType($0.formatDescription) == kCVPixelFormatType_1
})
if depth32formats.isEmpty {
    print("Device does not support Float32 depth format")
    setupResult = .configurationFailed
    session.commitConfiguration()
    return
}

let selectedFormat = depth32formats.max(by: { first, second in
    CMVideoFormatDescriptionGetDimensions(first.formatDescription).width <
    CMVideoFormatDescriptionGetDimensions(second.formatDescription).width })

```

Synchronize the normal RGB video data with depth data output. The first output in the `dataOutputs` array is the master output.

```

outputSynchronizer = AVCaptureDataOutputSynchronizer(dataOutputs: [videoDataOutput,
outputSynchronizer!.setDelegate(self, queue: dataOutputQueue)

```

Create a binary foreground mask

Assume the foreground to be a human face. You can accomplish face detection through the Vision framework's [VNDetectFaceRectanglesRequest](#), but this sample doesn't need anything else from Vision, so it's simpler to consult the [AVMetadataObject](#) for [face](#).

```

self.session.addOutput(metadataOutput)
if metadataOutput.availableMetadataObjectTypes.contains(.face) {
    metadataOutput.metadataObjectTypes = [.face]
}

```

Using the [AVMetadataObject](#), locate the face's bounding box and center. Assume there is only one face and take the first one in the metadata object.

```

if let syncedMetaData: AVCaptureSynchronizedMetadataObjectData =
    synchronizedDataCollection.synchronizedData(for: metadataOutput) as? AVCaptureSy
let firstFace = syncedMetaData.metadataObjects.first,
let connection = self.videoDataOutput.connection(with: AVMediaType.video),
let face = videoDataOutput.transformedMetadataObject(for: firstFace, connection:

```

```
let faceCenter = CGPoint(x: face.bounds.midX, y: face.bounds.midY)
```

Depth maps differ from their normal camera image counterparts in resolution; as a result, normal image coordinates differ from depth map coordinates by a scale factor. Compute the scale factor and transform the face's center to depth map coordinates.

```
let scaleFactor = CGFloat(CVPixelBufferGetWidth(depthPixelFormat)) / CGFloat(CVPixelBufferGetWidth(imagePixelFormat))
let pixelX = Int((faceCenter.x * scaleFactor).rounded())
let pixelY = Int((faceCenter.y * scaleFactor).rounded())
```

Once you have the face in depth map coordinates, threshold the image to create a binary mask image, where the foreground pixels are 1, and the background pixels are 0.

```
let depthWidth = CVPixelBufferGetWidth(depthPixelFormat)
let depthHeight = CVPixelBufferGetHeight(depthPixelFormat)

CVPixelBufferLockBaseAddress(depthPixelFormat, CVPixelBufferLockFlags(rawValue: 0))

for yMap in 0 ..< depthHeight {
    let rowData = CVPixelBufferGetBaseAddress(depthPixelFormat)! + yMap * CVPixelBufferBytesPerRow
    let data = UnsafeMutableBufferPointer<Float32>(start: rowData.assumingMemoryBound, count: depthWidth)
    for index in 0 ..< depthWidth {
        if data[index] > 0 && data[index] <= depthCutoff {
            data[index] = 1.0
        } else {
            data[index] = 0.0
        }
    }
}
```

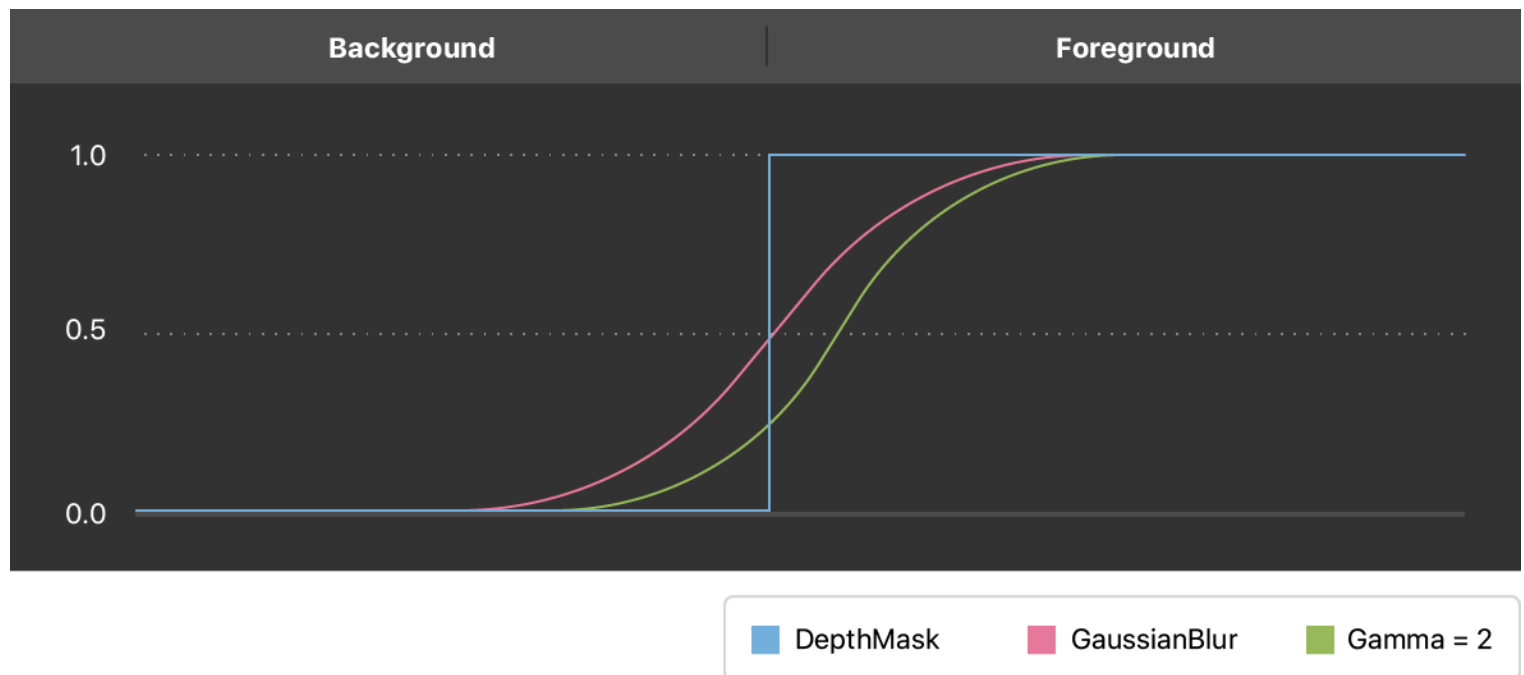
Smooth the depth mask with Core Image filters

The depth map doesn't share the RGB image's sharp resolution, so the mask may contain holes along the interface between foreground and background. Once you have a downsampled mask image, use a Gaussian filter to smooth out the holes, so the interface doesn't look jagged or pixelated. Clamp your image before filtering it, and crop it afterward, so it retains the proper size when applied with the original image.

```
let depthMaskImage = CIImage(cvPixelBuffer: depthPixelFormat, options: [:])
```

```
// Smooth edges to create an alpha matte, then upscale it to the RGB resolution.
let alphaUpscaleFactor = Float(CVPixelBufferGetWidth(videoPixelFormat)) / Float(depthMaskImage.extent.width)
let alphaMatte = depthMaskImage.clampedToExtent()
    .applyingFilter("CIGaussianBlur", parameters: ["inputRadius": blurRadius])
    .applyingFilter("CIGammaAdjust", parameters: ["inputPower": gamma])
    .cropped(to: depthMaskImage.extent)
    .applyingFilter("CIBicubicScaleTransform", parameters: ["inputScale": alphaUpscaleFactor])
```

The parameters of your `CIGaussianBlur` and `CIGammaAdjust` filters directly affect the smoothness of the edge pixels. You can tune the blur and smoothness by adjusting the Gaussian blur filter's input radius, as well as the gamma adjustment filter's input power.



Blend foreground and background with the alpha matte

The final step is applying your filtered smooth binary mask to the input video frame.

Because you've performed image processing in Core Image using the `CIGaussianBlur` and `CIGammaAdjust` filters, it's most computationally efficient to apply the resulting mask in Core Image, as well. That means converting your video from `CVPixelFormat` format to `CIImage` format, allowing you to apply the alpha matte to the original image, and blend in your custom background image with the `CIBlendWithMask` filter.

```
let image = CIImage(cvPixelFormat: videoPixelFormat)

// Apply alpha matte to the video.
var parameters = ["inputMaskImage": alphaMatte]
if let background = self.backgroundImage {
    parameters["inputBackgroundImage"] = background
}
```

```
}
```

```
let output = image.applyingFilter("CIBlendWithMask", parameters: parameters)
```

Update your preview to display the final composited image onscreen.

```
previewView.image = output
```

See Also

Depth data capture



Capturing photos with depth

Get a depth map with a photo to create effects like the system camera's Portrait mode (on compatible devices).



Creating auxiliary depth data manually

Generate a depth image and attach it to your own image.



Capturing depth using the LiDAR camera

Access the LiDAR camera on supporting devices to capture precise depth data.



AVCamFilter: Applying filters to a capture stream

Render a capture stream with rose-colored filtering and depth effects.



Streaming depth data from the TrueDepth camera

Visualize depth data in 2D and 3D from the TrueDepth camera.

```
class AVCaptureDepthDataOutput
```

A capture output that records scene depth information on compatible camera devices.

```
class AVDepthData
```

A container for per-pixel distance or disparity information captured by compatible camera devices.

```
class AVCaptureCalibrationData
```

Information about the camera characteristics used to capture images and depth data.