Oculus FPV

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Abstract

In this project we have attempted to combine virtual reality (VR) head mounted displays (HMDs) with modern unmanned aerial vehicle (UAV) technology, in order to pilot a DJI Phantom 2 drone through an Oculus Rift. In many situations, the need for access in order to perform visual inspection is important. In environments such as inaccessible terrain and tall buildings, the cost and risk of utilizing a human being as the medium of inspection may be too high. In such cases, a drone mounted with cameras which stream video to a VR headset will be able to perform satisfactory.

The completed product made it is possible to control the flight of a drone through its remote controller, while the operator at the same time is being shown the flight through an immersive video medium. The operator also has the choice to look around due to the camera platform being synchronized with the head tracking sensors in the HMD.

Introduction

As drone technology is becoming more and more ubiquitous, the possibility of combining it with other emerging technologies makes for several interesting projects. By using a standard drone and combining it with VR technology, it is possible to create immersive flight experiences. This can be used for personal enjoyment, as well as for performing tasks involving visual inspection of otherwise inaccessible structures and terrain features.

It should be noted that the following descriptional sections pertain a particular drone, the DJI Phantom 2 and the Oculus Rift Development Kit version 1 from Oculus VR. Different solutions will be necessary in order to replicate this project on other drones and head mounted displays. The overall design of the project involved three major components which needed to be completed in order to produce a final result. These components were the following:

Platform attached to drone

Figure 1 present a representation of the platform which was screwed onto the underside of the drone used in this project. The platform was made to hold cameras, servomotors and an microcontroller for updating the latter. Plywood was the material selected to serve as the frame of the platform.

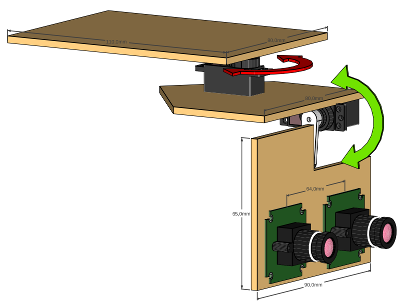

Figure 1: Platform used to hold cameras and servos. The servos are controlled by an microcontroller soldered to a circuitboard mounted on the platform (not shown).

Servo positions synchronized to HMD orientation

Oculus VR supplies a software development kit (SDK) for accessing features of the Oculus Rift. By using methods bundled in this SDK it is possible to extract the vector components which in sum represent the direction the HMD is pointing. Figure 2 shows the the different rotations which can be registrered. In this project, rotation about the z-axis, referred to as roll in aviation, is not supported by our drone mounted platform. Figure 1 shows that pitch and yaw will be the directions supported. The direction coordinates produced in the Oculus Rift are converted into a range which will be used to steer the servos. The coordinates are modified to be contained within a specific range, which is dictated by the rotational reach of the servos. The modified coordinates are then sent by serial wireless transmission, by employing a USB to serial *breakout board* connected to the operator's computer in one end and a serial transmitter in the other end. A reciever on the drone platform conveys the signal to the microcontroller, which employs pulse width modulation (PWM) in order to use the signal to update the servo positions.

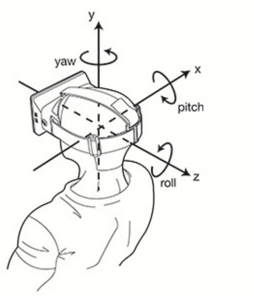

Figure 2: The Oculus Rift's right handed coordinate system. Rotations about the x-, y- and z-axes are referred to as pitch, yaw and roll, respectivly.

Conversion of video stream to VR HMD format

The cameras mounted on the drone will transmit video to a reciever connected to the operator's computer. This reciever deliver composite video, which must be converted to digital format in order to be able to process the video stream. This conversion is done by a external *composite to USB device*. The video stream is then subjected to real time manipulation, which serves the purpose of distorting the images into a format which can be viewed in the head mounted display. Each of the two video streams destined for each eye are *barrel distorted*, see Figure 3. The combined effect of barrel distortion and the pincushion distortion of the HMD's lens makes it is possible to achieve the effect of wrapping the image around the operators eyes. Oculus Rift is made to be plug-and-play, and is represented on the operators computer as an extra screen where it is possible to present the manipulated video stream.

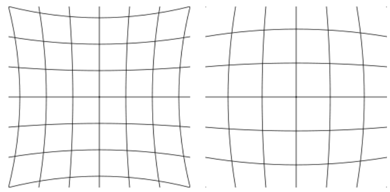

Figure 3: The left image represent the *pincushion distortion* of the lens in Oculus Rift. This bulges the image inwards. The right image represent the *barrel distortion*, which is what the video stream will be subjected to. Combined, these effects creates immersive video to be used in the Oculus Rift.

Results and discussion

The final result was a DJI Phantom 2 which could be piloted by an operator using Oculus Rift. The operator was presented video which was streamed live from the drone and the directionality of the cameras were controlled by the head movements of the operator. Issues regarding the product revolves particularly around the mounting of the cameras on the platform. Thorough care in aligning the cameras must be present in order to produce a trustworthy image with depth and complete immersive effect. A slight misalignment produces images for each eye which the operator's brain is not able to align. This results in the operator not being able to enjoy the flight, and it will tire out her brain and eyes. Much to the operators discomfort. It should be noted that the resolution in the Oculus Rift we employed made the image produced somewhat grainy. This is expected to be resolved in the upcoming HMDs from Oculus VR.

Reference list

The following url point to a repository containing the code we employed, product list, promo video and a expanded project report (in Norwegian): `https://github.com/Matsemann/oculus-fpv`