ECE 498 Signal and Image Analysis

Final Project

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1. Introduction

The final project is a 1min 13s long movie that uses signal and image processing techniques covered in all 7 labs throughout the semester.

The story of the short movie is that in the future, an alien creature named Wukong comes to earth and wants to occupy the earth.

I, as a representative of human beings, will have a fight with Wukong. The rule of the fight is to shoot a rifle at a target 10 m away. Both Wukong and I will have 10 shots. If I win, Wukong will go back to his planet; otherwise human beings will be eliminated.

My final score is 76; after 9 shots, Wukong's score is 74. If he got more than 2 points in the final shot, we will lose. And he got 10 for the final shot; however, he shoot the wrong target (my target). So we win the war and Wukong goes back to his planet. "I will be back", he says.

2. Movie Details

2.1 Background of story

The background information of the story is given in the beginning of the movie by sentences:

"In year 2638, we are attacked by an alien battleship, the alien's name is Wukong. Wukong wants to claim our beloved earth… "
"The war begins."
"Rules: 9mm rifle shooting, 10 shots."
"If I win, Wukong will go back to his planet; if he wins, humans will be eliminated."

The effects (subtitle, rectangular frame, etc.) are made using Coral VideoStudio in Windows. The background picture and music are downloaded from internet and integrated in Coral VideoStudio.

2.2 Connecting Wukong

After the background information is given, the human on earth are trying to connect Wukong, who is still in space. The sound effect "du-du-du-" (at around 23s) utilized the technique from lab 1. I

first recorded my natural vowel /a/, then I used only the first two harmonics of my vowel to resynthesize the electrical sound "du-". It represents the telephone connection sound.

At around 24s, Wukong picked up the phone and said to human, sound like a robot: "I will win, and you will be terminated!" I made this voice by first recording my natural speech in Matlab using *audiorecorder,* then I filtered the speech by a bandpass filter from 256Hz to 2200Hz using *firpm* function in Matlab to simulate Wukong's voice from radio signal. This is the technique from lab 5.

2.3 Shooting

Then comes the shooting scenes of me and Wukong (29s to 34s). These movies are actually recorded during Thanksgiving break at Bullet Trap, Macon, IL. My friends and I went shooting. The man in orange is me and the girl is my friend, acting as Wukong.

The video is filtered by a low-pass filter using *firpm* in Matlab: f=[0.0 0.01 0.3 1], a=[1 1 0 0] (lab 6). Only the video when I was shooting is filtered and the Wukong's shooting video is not filtered because the file size is too large. The purpose of the LPF is to de-noise the shooting video; as a result, the de-noised video is also a little blurred (29s to 30s).

It should be noted that both the shooting sound of me and Wukong are reverberating (30s and 33s). I used the original recorded gunshot sound and then filtered them using a feedback filter:

$$y[n] = x[n] - 0.6\,y[n - 0.3\,f_s]$$

where the scale parameter s=-0.6, the delay parameter d is 0.3s and fs is the sampling frequency of the voice. This is the technique from lab 3. The purpose is to make the gunshot sound echoing for a while (although there is no echo in the shooting range).

2.4 Target is changing

From 37s to 45s, both my and Wukong's target change from intact to the final stage.

"My final score is 76 while his score for the first 9 shots is 74."

The animation is made by up-sampling in time and space (lab 7). I first find an image of the intact target and an image of the target after shooting (made in Photoshop); then I up-sample the image by a factor of 4 in horizontal, vertical and temporal and use first order linear interpolation. In addition, I set the frame rate of the movie to 1.5 fps in order to make the target change slower. The purpose of this is to show the importance of Wukong's final shot – if he gets more than 2 points, we will lose.

2.5 Flying bullet and motion blur

From 45s to 49s, the flying bullets animation is made in matlab. I simply draw 3 circles for the target and one ellipse to represent the flying bullet. The purpose of this is to show the climax of the story – Wukong's final shot which will decide the fate of human beings.

Also I used the motion blur technique which is introduced in the final project demonstration to show the high speed of the bullet.

In the meantime, the background gunshot sound at 48s is again filtered by a feedback filter as described in section 2.3.

2.6 Result of Wukong's final shot

Wukong gets 10 points in his final shot. It seems that he wins the war; "however, nothing happens on his target" (from 51s to 52s). The reason turns out to be hilarious – Wukong shoots on my target instead of his target! The color of bullet hole at the center of my target changes from white to light green to emphasize his mistake (52s to 56s). This effect is again made by up-sampling in time.

At the same time Wukong said something like "ah~oh~" (55s). This effect is made by the synthetic vowel technique in lab 2. Both the vowel /a/ and /o/ have the form of

$$x[n] = e^{-n\pi B/F_s} \sin(n2\pi F / F_s) \ ,$$

where F1=900, F2=1200, B1=150, B2=150, A1=1, A2=0.75, Fs=8000 for vowel /a/ and F1=700, F2=760, B1=150, B2=250, A1=1, A2=0.8, Fs=8000 for vowel /o/. The purpose of this voice is to show Wukong's embarrassment.

2.7 Wukong Disappears

From 57s to 1min 2s, Wukong gradually disappears.

"Wukong is back to his own planet; human will live happily ever after…"

The effect is made by more and more heavily filtering the original Wukong image (downloaded on internet) using a "Sobel mask" as described in lab 4. The purpose of this is to make it look like Wukong is defeated by us. The music "Happy" by Pharrell is to show the exhilaration of human beings.

However, Wukong left a message from space:

"I'll be back" (1min 6s).

This dialog is originally from the movie “Terminator”. It is used here to make the ending of the story not so happy but more interesting. It is again filtered using a bandpass filter from 256Hz to 2200Hz using firpm function in Matlab to simulate Wukong’s voice from space.

3. Summary

3.1 Effect from ECE 498 labs

The movie effects that are from the labs content are summarized below.

Techniques	Harmonic removing	Damped sine speech	Feedback filter	Edge detection	Audio BPF	Image LPF	Up-sample and interpolation	Animation, motion blur
From	Lab 1	Lab 2	Lab 3	Lab 4	Lab 5	Lab 6	Lab 7	Final project demo
Time	23s	55s	30s, 33s, 48s	57s to 1min 2s	24s, 1min 6s	29s to 32s	37s to 45s, 52s to 56s	45s to 49s
Effects	Phone connecting sound	Synthesize Wukong voice	Gunshot echoes	Wukong Disappears	Space radio effect	Movie denoise	Slow motion	Fast flying bullet

3.2 Movie making software

Apart from all the effects summarized in section 3.1, all other effects including subtitles are made by the built-in effects in the movie making software *Coral VideoStudio*.

All images and music tracks are downloaded from internet except the shooting scenes which were recorded by me and my friend in Bullet Trap.

3.3 The story of Wukong

Sun Wukong (or the Monkey King) is a character from Chinese classical novel *Journey to the West.* He is a good monkey in the novel but I just steal his name to make this short movie.