DUCK HUNT

GAME A  1 DUCK
GAME B  2 DUCKS
GAME C  CLAY SHOOTING
GAME D  DOGS

INSTRUCTIONS  SHOW MOUSE

TOP SCORE = 10500

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REMADE BY PSHYKOH  http://pshykohtech.cjb.net
Laser Shot

A Video-based Alternative to Arcade Light Guns

By Tiffany Chen, Spencer Sugimoto, and Paul Yang
Introduction

- Dot Finder
- Duck Hunt System
- Potential Issues
- Materials Needed
Dot Finder

Goal: Given an camera view of the screen with the laser dot, find the coordinates of the dot on the screen.

Screen Location of Dot

What the Camera Sees

(0,0) ➔ (799,0)

(x,y) ➔

(799,0) ➔ (799,599)
Dot Finder Algorithm

- Remove blue, green
- Apply a threshold
Dot Finder Algorithm

- Find the center of mass of resulting dot
- Apply a perspective transformation of the form

\[
X = \frac{ax + by + c}{gx + hy + 1} \\
Y = \frac{dx + ey + f}{gx + hy + 1}
\]

*(x,y) – coordinates of dot in camera image
(X,Y) – coordinates of the dot on the screen
a,b,c,d,e,f,g,h – calibration coefficients

1 Perspective Transform Estimation - <http://alumni.media.mit.edu/~cwren/interpolator/>
Dot Finder Block Diagram

- tv_in_ycrcb
- threshold
- set
- corner_select
- vcount
- hcount

Center of Mass

Coordinate Transformer

Calibration Coefficients

a,b,c,d,e,f,g

pixel
Dot Finder – Center of Mass

NTSC Decoder

Pixel x,y Counter

YCrCb to RGB

Red Filter

Threshold

Point Average

tv_in_ycrcb

ycrcb

f

v

h

x

y

cr

cb

x

y

r

g

b

x

y

x

y

red

threshold

Threshold

Point Average

x

y

v

x

y
Duck Hunt System

- 800 x 600, 60 Hz display
- Shoot ducks before time runs out
- Features
  - Animated ducks and bushes
  - Sound effects
  - Score keeping & timing
Duck Hunt System - Cloud Generator

- Clouds move at constant speed across the sky
Duck Hunt System - Bush Generator

- Bushes are hard coded onto the screen
- Bushes sway left and right each second
- If a bush is selected, bush shudders
Duck Hunt System - Bush FSM

FSM Component

- State 00: Bush Right
- State 01: Bush Left
- State 11: Up Left
- State 10: Up Right

- Default progression: bushes sway left and right
- If bush_select ever goes high, bush shudders
Duck Hunt System – Score Keeper

- Increments score whenever a duck is shot
- Displays current score
- Counts down time
- Indicates a game over

```
from duck_controller
from second_timer
from video_controller

life
one_hz_enable
score_enable

score_keeper

score_rgb
  to video_controller
  to audio_controller

gameover
  to video_controller
```
Duck Hunt System - Duck Modules

- Duck ROM: 45 KB
- From dot finder
  - To score keeper, audio handler
- To & from video controller
  - Timer
- Second timer
- Ducked RGB
- Duck address
- Duck enable
- Duck enable
- Expire
- Appearance enable
- Appearance
- Random number generator
- Bush generator
- Speed determination
- Speed enable
- Speed enable
- Speed enable
- Life
- Trigger
Duck Hunt System - Duck Controller

- Compares x & y coordinates of laser dot to duck coordinates
- Takes 3 shots to kill duck
Duck Hunt System - Video Controller

- Priority encoder
  - Ensures ducks hide behind bushes & clouds
  - Outputs pixel RGBs
  - Controls image transparency

```
display

3 pixel

bush_rgb
cloud_rgb
score_rgb
gameover
duck_rgb

video controller

cloud_speed
score_enable
duck_enable
```
Duck Hunt System - Audio Controller

- **Sound Selector**
  - Chooses sound to output to speaker
  - Duck death, Laser shot, Bush rustle, Gameover, Duck Flapping

```python
audio_handler
addr = (x || y) ? shot :
  life ? shudder :
  death;
```

- Speaker
  - 4

- Audio ROM
  - 144 KB

- (from Scorekeeper)
  - gameover

- (from Dot Finder)
  - trigger
  - life

- (from Duck Handler)
  - addr
  - sound_data
Timeline

- 11/22 Center of Mass Module fully functional, Duck module basic functionality
- 11/29 Dot Finder fully functional; Duck and Video Controller fully functional; Bush module, scorekeeping, and Audio fully functional
- 12/4 Initial integration of dot finder & duck hunt system
- 12/11 finish debugging & final checkoff
Materials Needed

- NES Light “Zapper” Gun
- 5mW Red Laser Pointer
- 10mW Green Laser Pointer
- Plastic Sheet
- Fine-Grit Sandpaper
Dot Finder – Potential Issues

- **Reflectivity** - Dot must be brightest object on screen
  - LCD reflectivity may not reflect laser strongly enough
  - Use a diffusive reflector overlay or brighter laser

- **Noise** - Assumed noise was low enough such that the threshold filter would be sufficient
  - If not, and mean or median filter will be necessary

- **Other**
  - Over saturation of image
  - Difficult perspective transform
  - Accuracy
  - Blurring of dot due to exposure times