

ECSE 6620: COMPUTER VISION FOR VISUAL EFFECTS
FINAL PROJECT PROGRESS REPORT
RPI FALL 2019

SUPER SNEVY

HAYLEY AND JOHN SAVE THE WORLD FROM A GIGANTIC EVIL MONSTER

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SNEVY'S SCAVENGER HUNT THROUGH TIME AND SPACE

1. Introduction

- The magical intergalactic Snevy travels through space and time to enlist Hayley to defeat an evil monster that is trying to take over the world. Hayley agrees but first needs to grab some coffee. Hayley uses multi-dimensional travel to go back in time and take the coffee she had that morning from her past self. She ends up running into John who is frantically running from a bee (John does not like bees). After Hayley neutralizes the bee, John agrees to help her defeat the monster. They find where the monster is located (at the VCC) and battle it (in a moving camera shot) to the death. The monster is defeated, the world is saved, and most importantly Snevy is happy.

2. Storyboard:

- **See attached storyboard**
- Shots 1-5: 30 seconds
- Shots 6-7: 25 seconds
- Shots 8-10: 20 seconds for bee-scene; 10 seconds for Snevy speaking
- Shots 11-13: 25 seconds

3. Related Work

- At the present time, several major effects have been identified for inclusion in the final video. The first effect is bounding box tracking. This effect will be used to superimpose videos, images, text, and other computer-generated objects onto manually marked bounding boxes enclosing both planar and non-planar objects in a video frame. The Harris-laplacian detector will be used to detect features in subsequent (unmarked) frames and normalized cross-correlation will be used to compute correspondences as demonstrated in [1]. The second effect is a combination of image matting and image compositing. A combination of GrabCut image matting as demonstrated in [2] and Blue Screen matting as demonstrated in [12] will be used to cut objects off of images with both natural and green-screened backgrounds. Poisson image compositing will be used to paste objects onto new backgrounds in the film as specified in [3]. The third major effect is a “twinning effect” as demonstrated in the music video “Come” by Jain [4]; this effect will be implemented using a variation of the seam carving algorithm presented in [7]. The fourth effect involves acquiring a 3D object and anchoring this object onto a fixed structure in footage collected using a moving Steadicam. The 3D object acquisition will be done via structured light scanning; the structured light scanning method based on Gray codes [5] will be utilized. To anchor the object onto the fixed structure, matchmoving techniques like those used in

the Avatar movie [6] will be used in this project. In addition to the effects mentioned, some CG objects and animations like smoke and fire may be used in the final film.

4. Data Collection

- Shots 1-5:
 - i. Base Video: Hayley Waking Up from Bed
 - Completed.
 - ii. Add-in Video 1: Spevy Puppet In front of green screen
 - To be recorded by 11/03.
 - An at-home greenscreen has been purchased to record the scene at home.
 - iii. Add-in Video 2: Evil goliath/monster for hologram
 - To be recorded by 11/03.
 - An at-home greenscreen has been purchased to record the scene at home.
- Shots 6-7:
 - i. Base Video 1: Past Hayley Putting Down Coffee and Clothes
 - Completed.
 - ii. Base Video 2: Future Hayley Stealing Coffee and Clothes
 - Completed.
- Shots 8-10:
 - i. Base Video: John Being Attacked by Bee, Hayley Saving Him, Speaking to Sneyv
 - To be recorded by 11/17.
 - ii. Add-in Video: Spevy Puppet In front of green screen
 - To be recorded by 11/03.
 - An at-home greenscreen has been purchased to record the scene at home.
- Shots 11-13: Hayley and John Battling the Goliath (Steadicam scene)
 - i. Base Video: Hayley and John in front of the VCC doing karate kicks.
 - Completed via Steadicam in Activity 2.

5. Technical Approach

- Effect 1: Bounding Box Tracking
 - a. Implementation Tools: This effect will be created primarily using custom Python or Matlab code and applicable library tools; professional editing tools like Adobe After Effects may be used to compliment the coding implementation
 - b. Implementation Approach:

- i. Manually annotate an object such that it is enclosed by a bounding box in the first frame of a scene
- ii. In subsequent frames use the Harris-laplacian detector to find keypoints which is based on a scale-normalized autocorrelation matrix specified in *Section 2* of [1]:

$$M(X, \sigma_1, \sigma_D) = \sigma_D^2 g(\sigma_I) \otimes \begin{bmatrix} I_x^2(X, \sigma_D) & I_x I_y(X, \sigma_D) \\ I_x I_y(X, \sigma_D) & I_y^2(X, \sigma_D) \end{bmatrix}$$

- iii. Use a normalized-cross correlation similarity measure to find feature correspondences between every consecutive pair of frames like that specified in *Section 3* of [1].

$$S_{m_1, m_2} = \frac{\sum_{u=-w}^w \sum_{v=-w}^w [A_{uv} - \bar{A}] \cdot [B_{uv} - \bar{B}]}{(2w+1)(2w+1)\sigma(A)\sigma(B)},$$

- iv. Use the detected bounding box points to superimpose external images, movies, or frames into the bounding box as it moves (due to the object it encloses moving or the camera). Image warping will be necessary to accomplish this goal.

- Effect 2: Image Matting and Image Compositing
 - a. Implementation Tools: This effect will be created primarily using custom Python or Matlab code and applicable library tools; professional editing tools like Adobe After Effects may be used to compliment the coding implementation
 - b. Implementation Approach:
 - i. GrabCut Matting [2]:
 1. Manually create a trimap to specify regions of the input image that are definitely background and definitely foreground
 2. Estimate the probability of each unmarked pixel being foreground and background using a probability distribution function based on the marked-pixel color histograms

3. Utilize the min-cut graph segmentation algorithm based on [8] to extract an image matte.
- ii. Blue Screen Matting [12]:
 1. Build matte using an alpha approximated with manually selected parameters a_1 and a_2 as shown in the equation $a = 1 - a_1(I_g - a_2 I_r)$
 2. This equation has been modified for use on a green screen; it was originally intended for blue screens
- iii. Poisson Compositing [3]:
 1. Define the matte extracted from GrabCut as m , corresponding source image as g , and background image as f^* .
 2. Use the mixed-gradient approach specified in *Section 3* of [3] to blend f and g where m is not 0:

$$\text{for all } \mathbf{x} \in \Omega, \mathbf{v}(\mathbf{x}) = \begin{cases} \nabla f^*(\mathbf{x}) & \text{if } |\nabla f^*(\mathbf{x})| > |\nabla g(\mathbf{x})|, \\ \nabla g(\mathbf{x}) & \text{otherwise.} \end{cases} \quad (12)$$

- Effect 3: Twinning Effect
 - a. Implementation Tools: This effect will be created primarily using custom Python or Matlab code and applicable library tools; professional editing tools like Adobe After Effects may be used to compliment the coding implementation
 - b. Implementation Approach:
 - i. Film two videos in the same setting with the same actors such that they can be stitched via some seam to make it appear like the actor is interacting with their clone/twin
 - ii. The seam will be found automatically using a variation of Forward Energy Seam Carving which is defined in the [5] as:

$$M(i, j) = P(i, j) + \min \begin{cases} M(i - 1, j - 1) + C_L(i, j) \\ M(i - 1, j) + C_U(i, j), \\ M(i - 1, j + 1) + C_R(i, j) \end{cases} \quad (2)$$

where $P(i, j)$ is an additional pixel based energy measure, such as the result of high level tasks (e.g. face detector) or user supplied weight, that can be used on top of the forward energy cost.

$$\begin{aligned}
 (a) \quad & C_L(i, j) = |I(i, j + 1) - I(i, j - 1)| + |I(i - 1, j) - I(i, j - 1)| \\
 (b) \quad & C_U(i, j) = |I(i, j + 1) - I(i, j - 1)| \\
 (c) \quad & C_R(i, j) = |I(i, j + 1) - I(i, j - 1)| + |I(i - 1, j) - I(i, j + 1)|
 \end{aligned}$$

- Effect 4: Steadicam, 3D Acquisition and Matchmoving
 - a. Implementation Tools: This effect will be carried out using research-level code and professional video editing tools
 - b. Implementation Approach: A 3D object will be acquired using the following software and tutorial [10]. Matchmoving will be implemented using Boujou [9] by reading and watching various online tutorials.

6. Preliminary Results

- Acquired Footage/Images as of October 17, 2019:

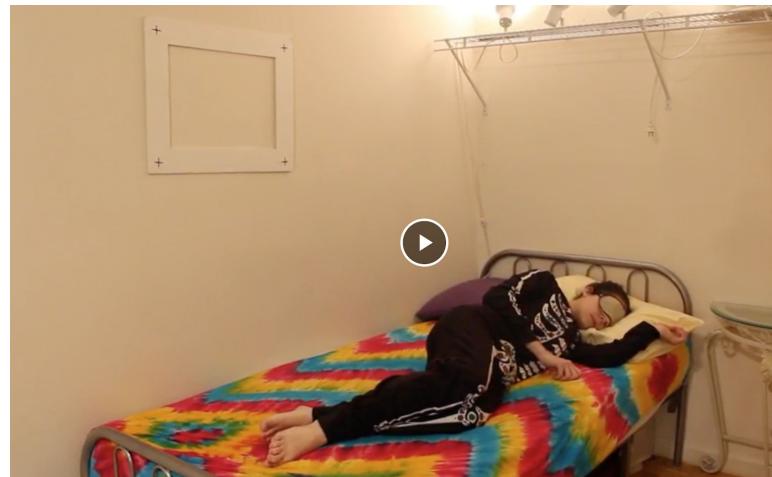


Figure 1: Opening scene with slow moving camera; the picture frame will be tracked here (the corners specifically); frame will originally contain picture of Sneyv; however this will change to a galaxy portal-like clip at some point; Hayley will be “zapped” into the portal and “transported” to the next scene.



Figure 2: Sneyv the mountain goat; will be matted using heuristic-based green screen matting or GrabCut matting, depending on which produces better quality results.



Figure 3: Footage for the twinning effect scene in which “present” Hayley steals Coffee from “past” Hayley.



Figure 4: Steadicam footage in front of VCC at two different times; will be used for “monster fight” scene; the monster (a 3D object acquired via structured light) will be anchored to the side of the VCC using matchmoving software.

- Algorithmic Discussion:

Algorithms for GrabCut Matting and Forward Energy Seam Carving were coded up in prior homework assignments. However, there are some implementation issues that will need to be resolved and additional extensions that will need to be added to enhance the performance of these algorithms for use in the final project. One such performance enhancement to the GrabCut Matting algorithm could be grouping similar pixels into regions called “superpixels” as was done in [11]. The Forward Energy Seam Carving algorithm in the first homework always ended up choosing straight lines for seams. However, the least energy seam in an

image should (most likely) not be a straight line (Figure 5). This issue will be fixed prior to the creation of the final video.

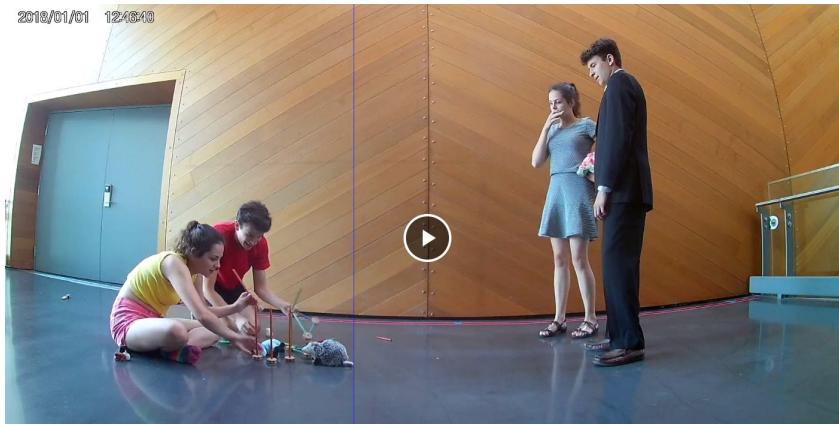


Figure 5: The vertical blue line off-set slightly to the left of the center of the image represents the least energy seam; this is where two videos are stitched to create a twinning effect; the blue line should (most likely) not be straight; this is an implementation issue with the Forward Energy Seam Carving algorithm that will need to be fixed.

7. Plan for Completion and Further Work

Dates:	Tasks:
Week of Oct 21st	Finish Filming Of Sneyv and Goliath in front of Green Screen (Add-in for shots 2,3,10,11,12)
Week of Oct 28th	
Week of Nov 4th	Film base video for John being attached by bee (Shot 8), being saved by Hayley (Shot 9), and Hayley/John speaking with Sneyv (Shot 10).
Week of Nov 11th	Start Cleaning Footage and idenitifying which takes will be used. Clip out exact scenes.
Week of Nov 18th	Complete first (lowest layer) effects. Twinning (Shots 6,7). Plane tracking and super impose painting/portal (Shots 1-5).
Week of Nov 25th	Insert all greenscreen/2D characters (middle layer) effects. Composite Sneyv (Shots1-3, 10). Composite Goliath (Shot 3). Composite Goliath

	with feature tracking (Shot 11, 12). Composite 2D Cartoon Bee with feature tracking (Shot 8, 9).
Week of Dec 2nd	Final Effect Add-ins (top layer effects): Speech bubbles (Shots 3,4,10,13), zap effect (Shot 5), and zap super powers (Shots 11, 12).
12/09/19	FINAL DUE DATE

8. References

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DOI: <https://doi.org/10.1145/1015706.1015719>
12. P. Vlahos. Electronic composite photography, 1971. US Patent 3,595,987.

Progress Report

Storyboard

— 3 2 1 —

ACTION

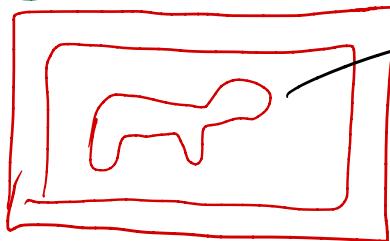


Effects denoted by $\#$

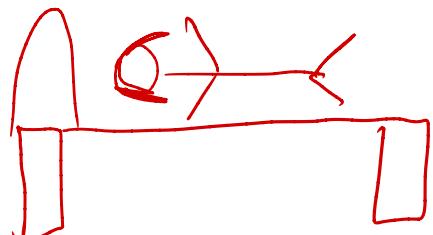
See "Technical Approach"

Shot 1: section for effect definitions

(1)

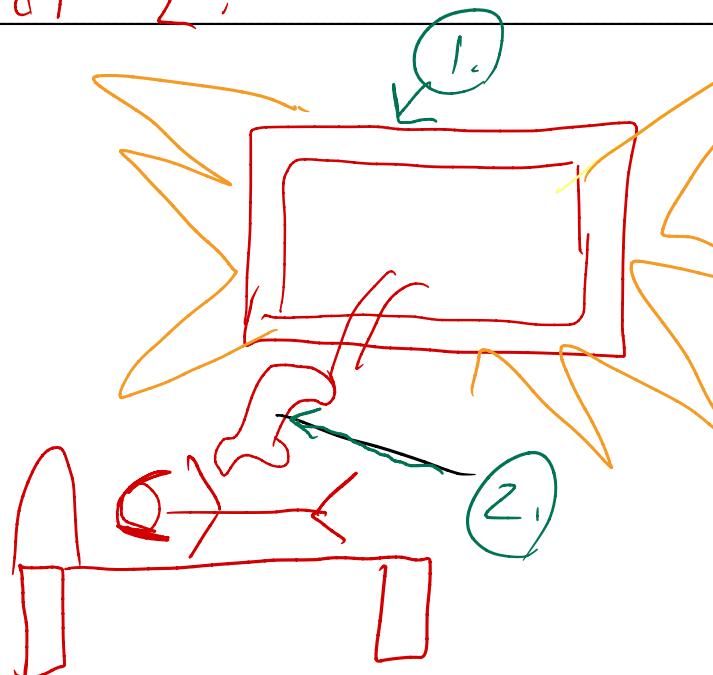


Picture of
Shevy the
mountain goat
on wall



Hayley sleeping

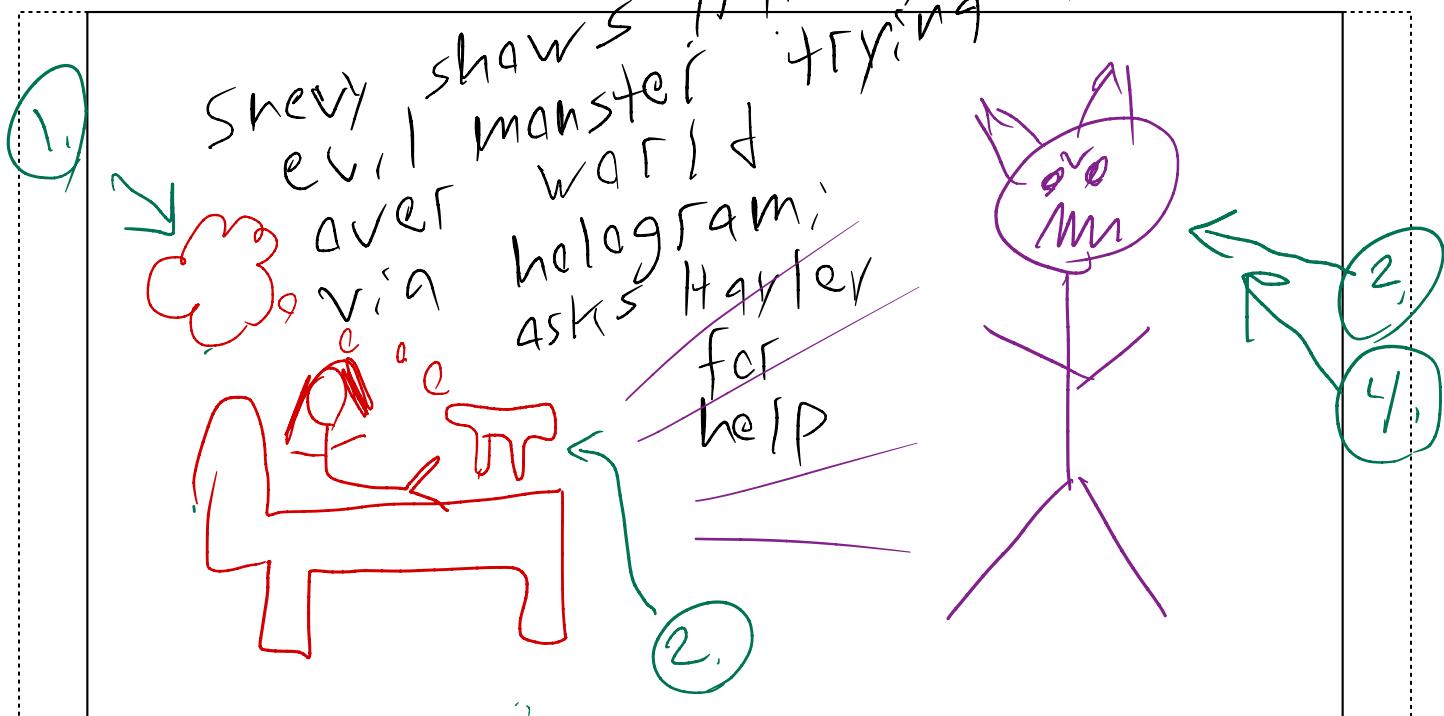
Shot 2:



— flash of
light,
Shevy jumps
out of
picture frame
and wakes
Hayley up.

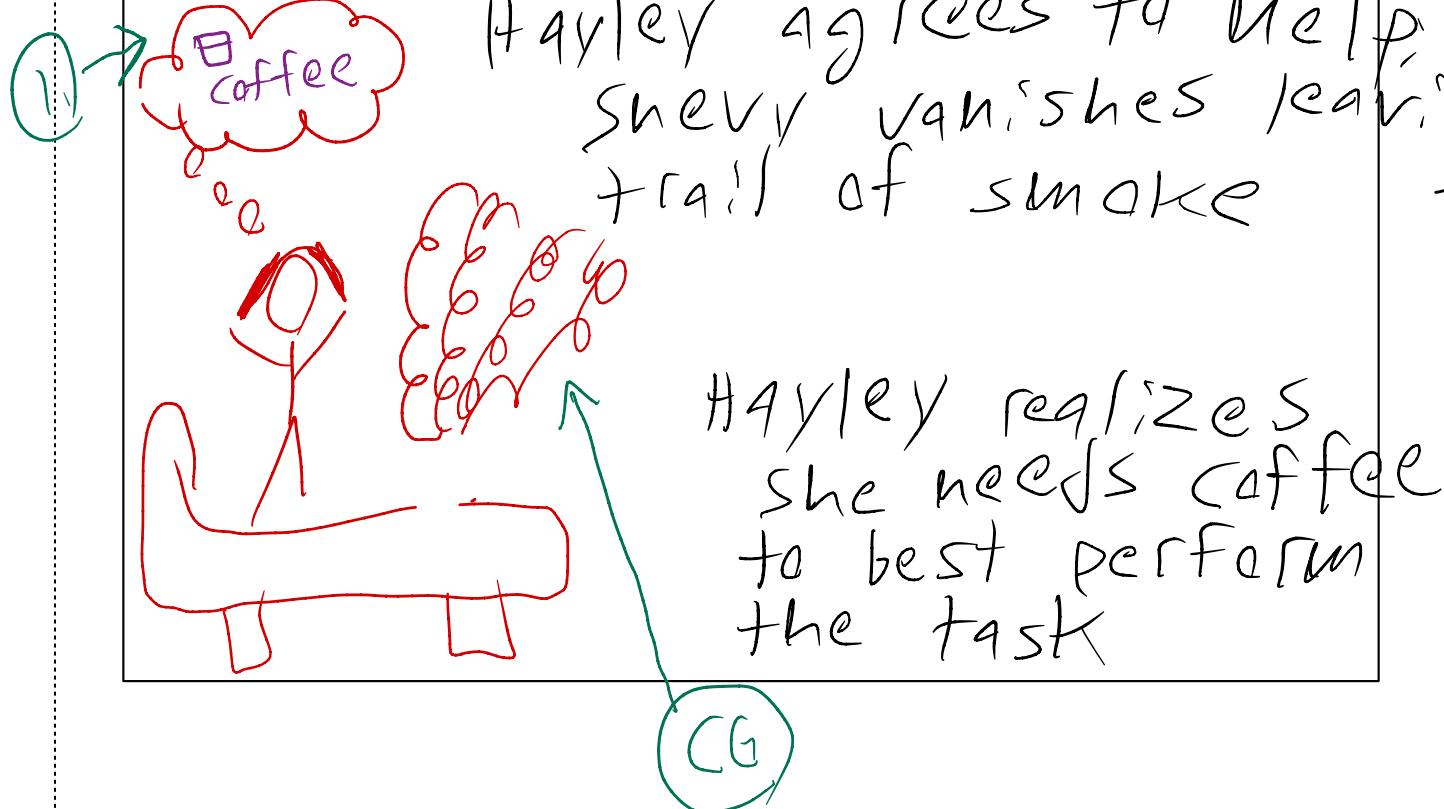
Shot 3:

Hayley agrees to take



Shot 4

Hayley agrees to help
Shevy vanishes leaving
trail of smoke



Shot 5

(CG)

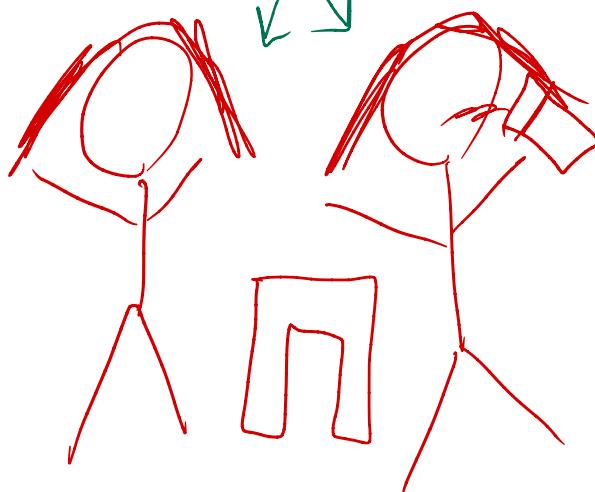
1)



PICTURE IN PICTURE
FRAME STARTS "SWIRLING"
LOOKS LIKE MOVING
GALAXY. HAYLEY
GETS ZAPPED IN

Shot 6

3.)



HAYLEY WINDS UP
IN HER KITCHEN IN THE
PREVIOUS DAY; SHE
SEES HER PREVIOUS
SELF DRINKING
COFFEE

Shot 7



when "past" Hayley puts the coffee down on a table, "present" Hayley steals it and runs

Shot 8



Hayley ends up running into John who is being chased by a bee

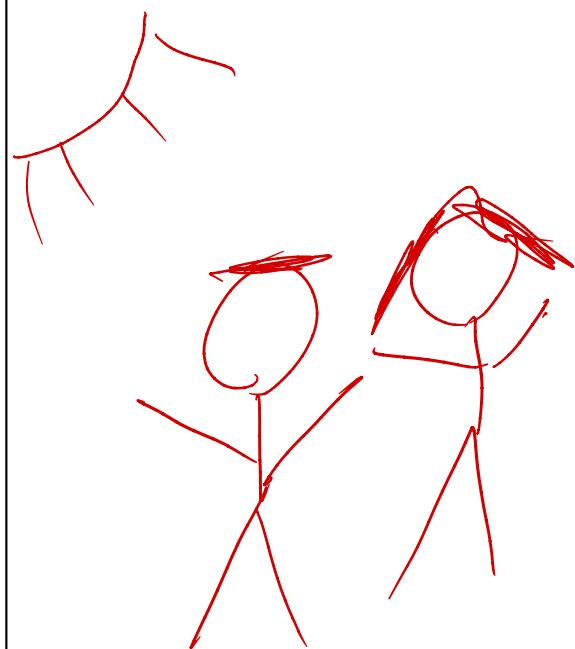
Shot 9



Harley hits
bee with
big swatter

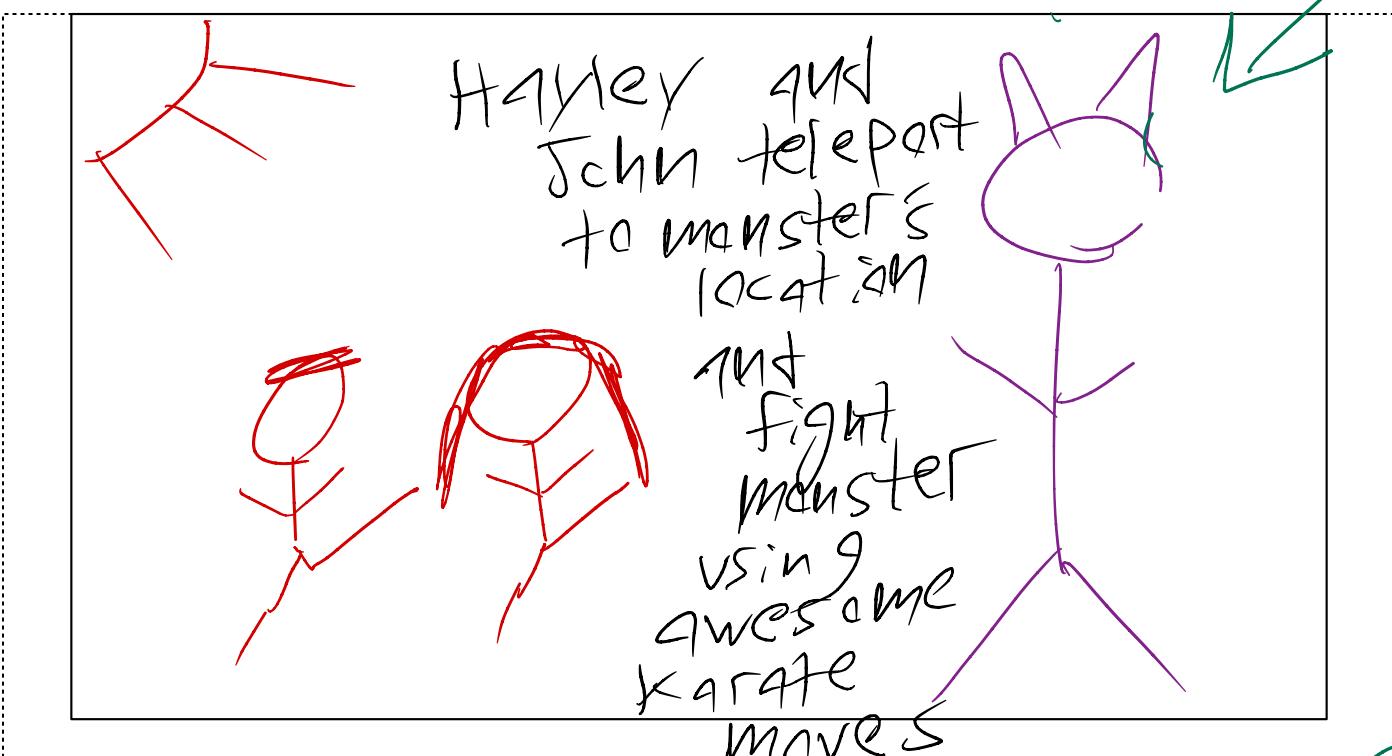
When John calms
down she asks him
to help her defeat
the monster

Shot 10



Sherly appears in
holographic form,
says time is
limited,
informs
Harley
and John
exactly
where
the monster
is.

Shot 11

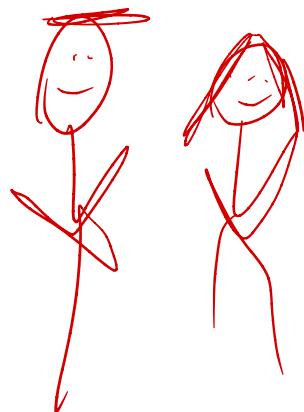


Shot 12



13

Lippee!



Hayley
& John
celebrate

THE END