COMPUTER VISION ROCK CLIMBING USING RGB VIDEO

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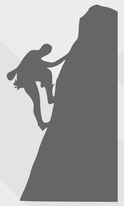
INTRODUCTION

In recent years, rock climbing has gained more popularity and more traction among people around the world. In this project we used recent advances in computer vision and convolutional neural networks to **automate a system that will assist rock climbers while they are climbing routes in their local bouldering gym**. Our project utilizes a **single RGB camera** that is mounted on a tripod 5-10 meters away from the rock wall in order to capture the entire wall and climber in its field of view.



We aim to provide interesting visualizations showing which handles a climber came in contact with and their pose throughout the climbing session. To accomplish this, we decompose our system into four central components:

- Rock climbing handle detection.
- Climber isolation from background.
- Accurate climber pose estimation (to obtain locations of joints).
- Handle interaction detection.

FUTURE WORK

There are many different directions for future work that we have considered while working on this project. Directions include:

- Rock climbing game using a projector.
- Simulate new routes given the pose information of many different climbers. This gives a lot more flexibility to the route setters.
- Multi-climber pose tracking.

METHODS / RESULTS

HANDLE DETECTION

- 1000 manually labeled examples of handles.
- Histogram of oriented gradients (HoG) features.
- DLIB SVM based detection, using hard-negatives found in image.

CLIMBER ISOLATION

- Absolute difference of background image (containing no climber) and foreground video frame (containing climber).
- Threshold to produce binary image and dilate to fill in small noise holes.
- Find largest image contour over a threshold size to retrieve a padded bounding box of the climber.

POSE ESTIMATION

- Stacked Hourglass Convolutional Neural Network, trained on MPII and FLIC pose datasets.
- Input: a down-sampled climber isolation box, padded to be square. Output: heat map of various joint location probabilities.
- Local maximums computed to retrieve joint locations.
- Back projection to video reference using bounding box locations.
- Temporal outlier detection and smoothing of pose signal.

HANDLE HOLDING DETECTION

- Decaying heatmap of hands and feet locations.
- 2D spatial gaussian added to heat map at current joint locations.
- Entire heat map multiplied by a decay factor (e.g. 0.9).
- Threshold to detect pauses (holding).
- Cross reference with handle detection boxes to determine collison.