

# CrispyMcMark

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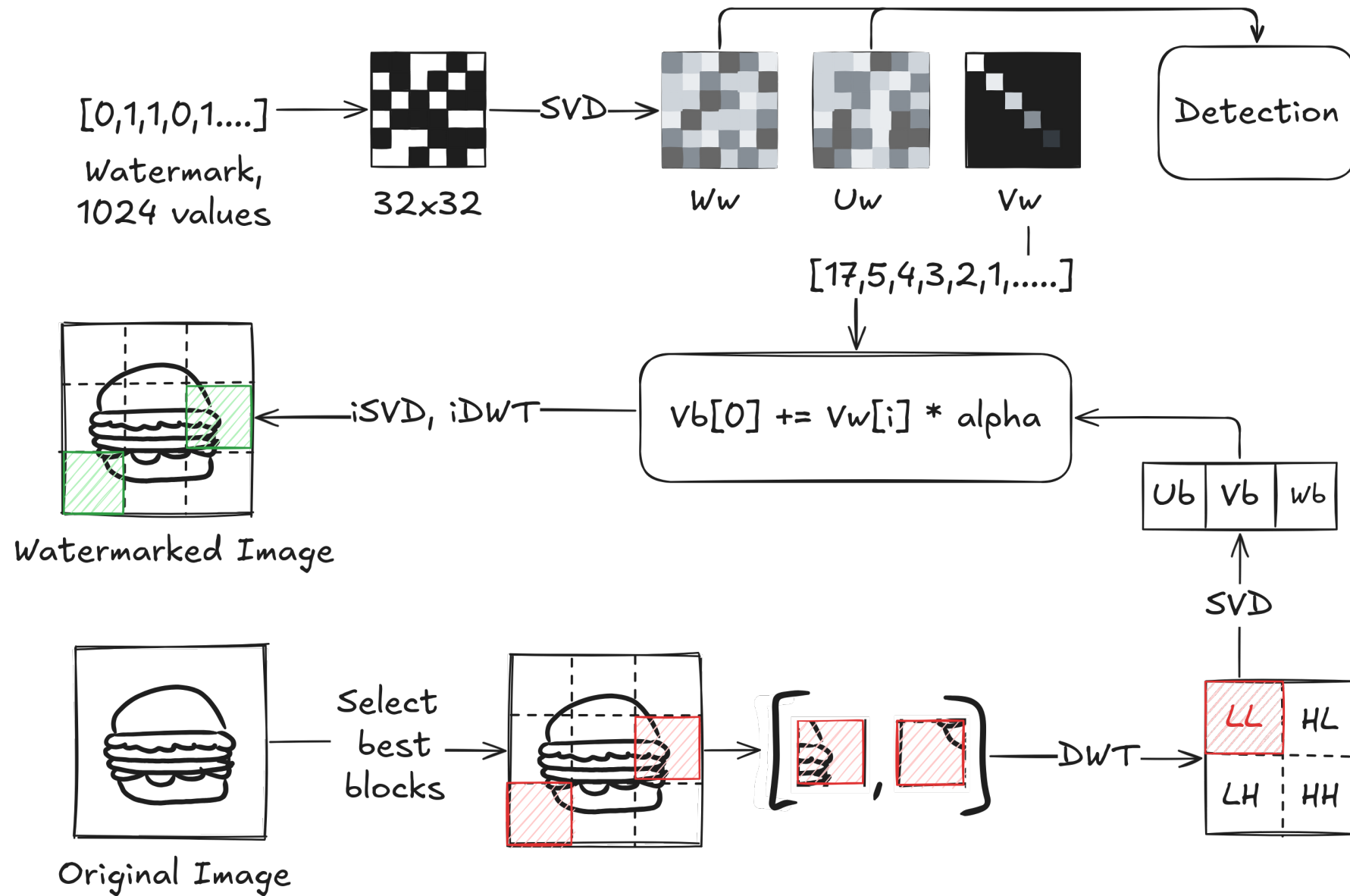


# How we reached the final implementation

- found papers about DWT-SVD
- began with DWT-SVD on the whole image
- then transitioned to blocks, embedding two singular values for each block
- switched to embedding one singular value per block

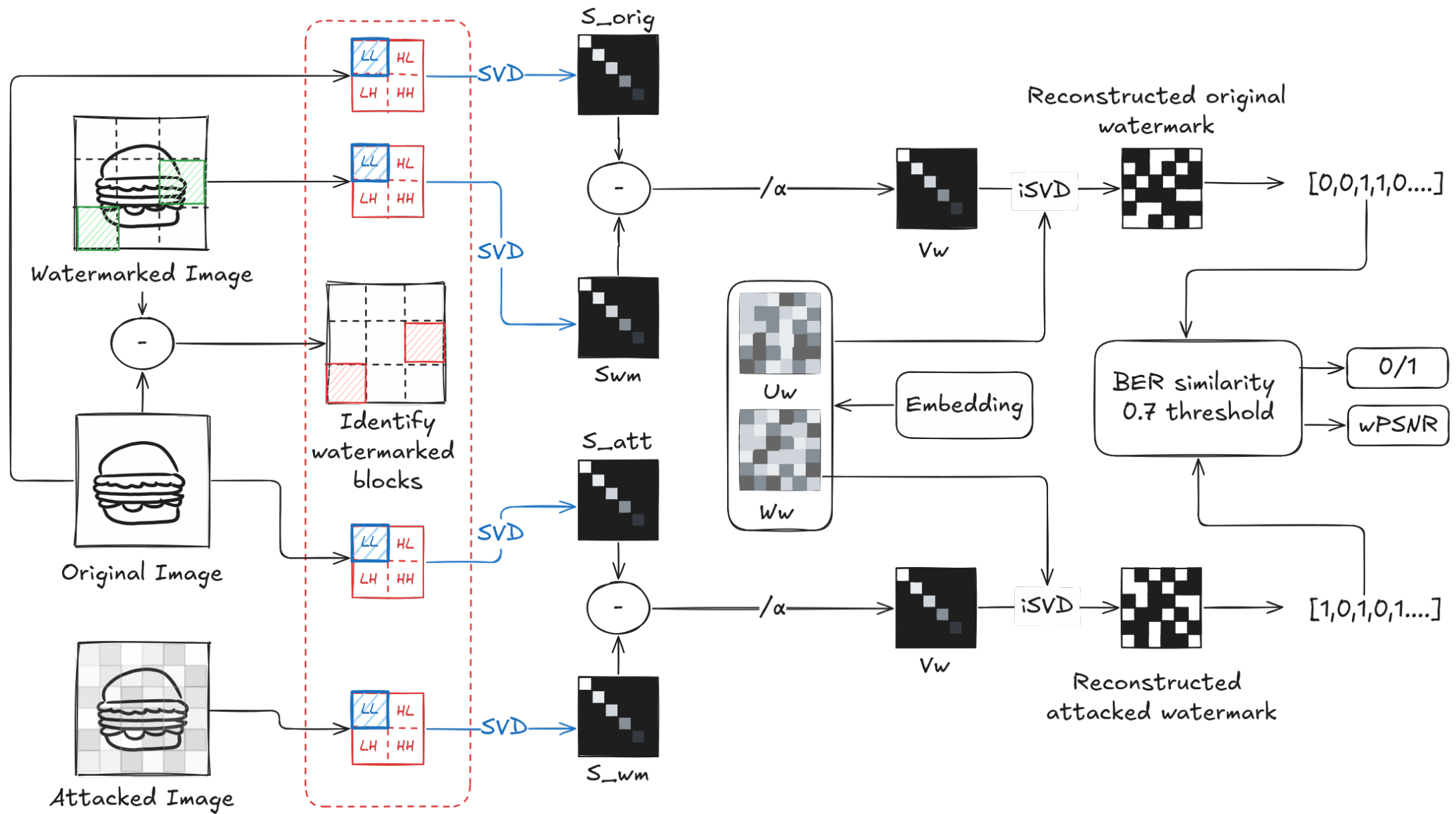
# Embedding

- reshape watermark to 32x32 and take  $U_w, V_w, W_w = SVD(watermark)$
- $U_w, W_w$  hardcoded in the detection,  $V_w$  are the singular values
- choose  $x$  square blocks
- forall  $i < x$ :
  - take  $LL_b$  of the DWT of  $blocks[i]$
  - compute the singular values  $V_b$  of its  $LL$
  - embed  $V[i]$  into the first singular value( $V_b[0]$ )
  - inverse the first two steps to reconstruct the block, and put it back into the image



# Detection

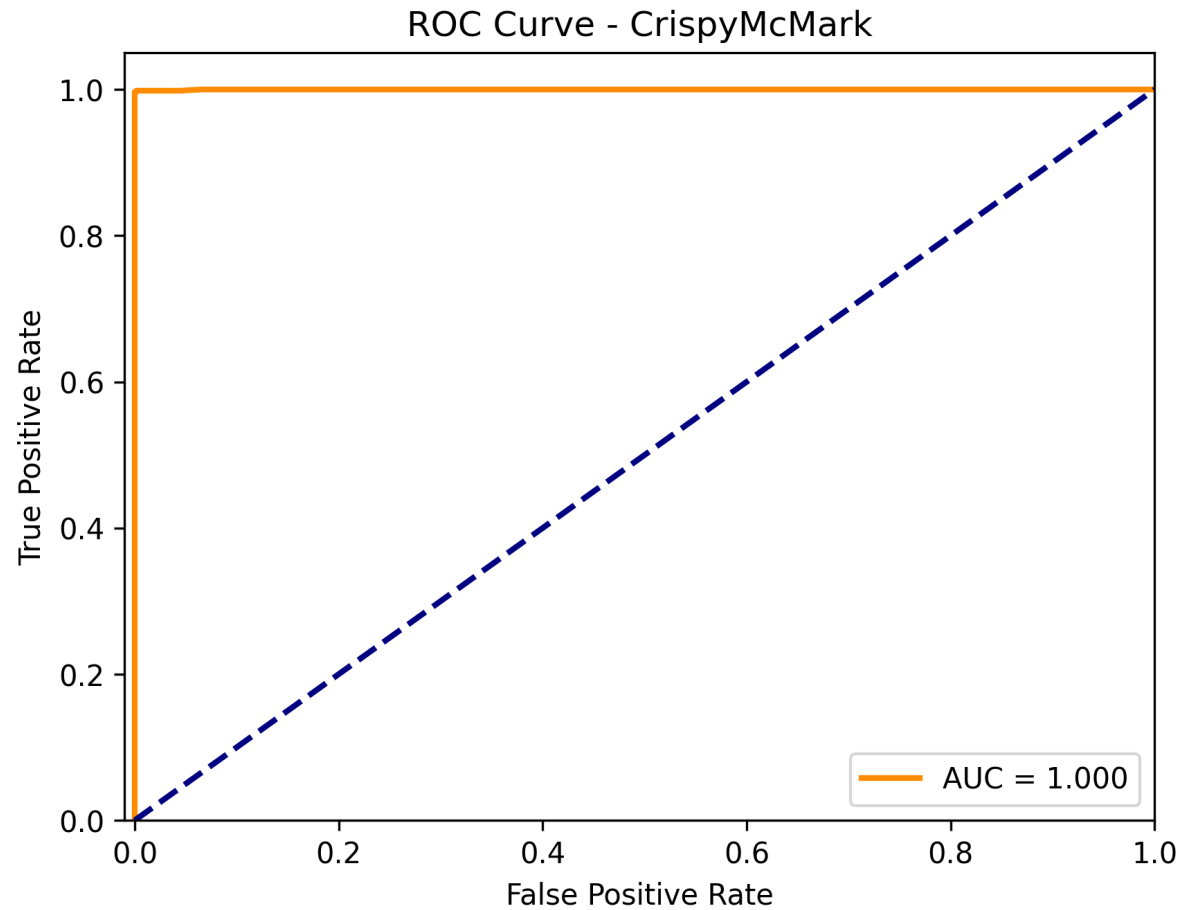
- use watermarked - original image to find  $x$  watermarked blocks
- attacked watermark = difference between singular values of attacked blocks and original blocks
- original watermark = difference between singular values of watermarked blocks and original blocks
- detection compares the two extracted watermarks using threshold



# Implementation challenges

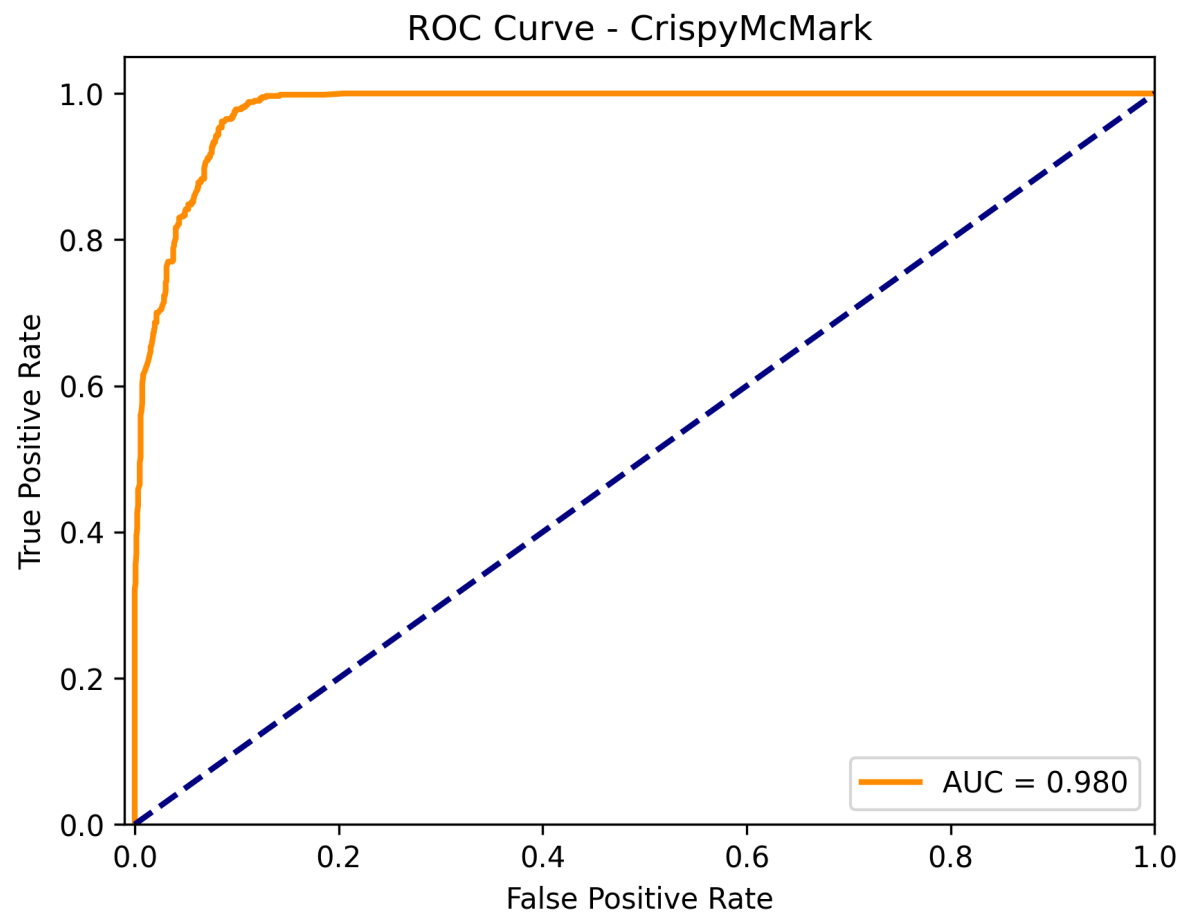
- Embedding quality performed better on images with high entropy zones
- On low entropy images embedding was more visible
- Not enough time to refine the design and try different techniques
- Multiplicative embedding was harder to tweak
- Understanding how the algorithm performed/finding bugs based on the ROC function.

# ROC1: Original



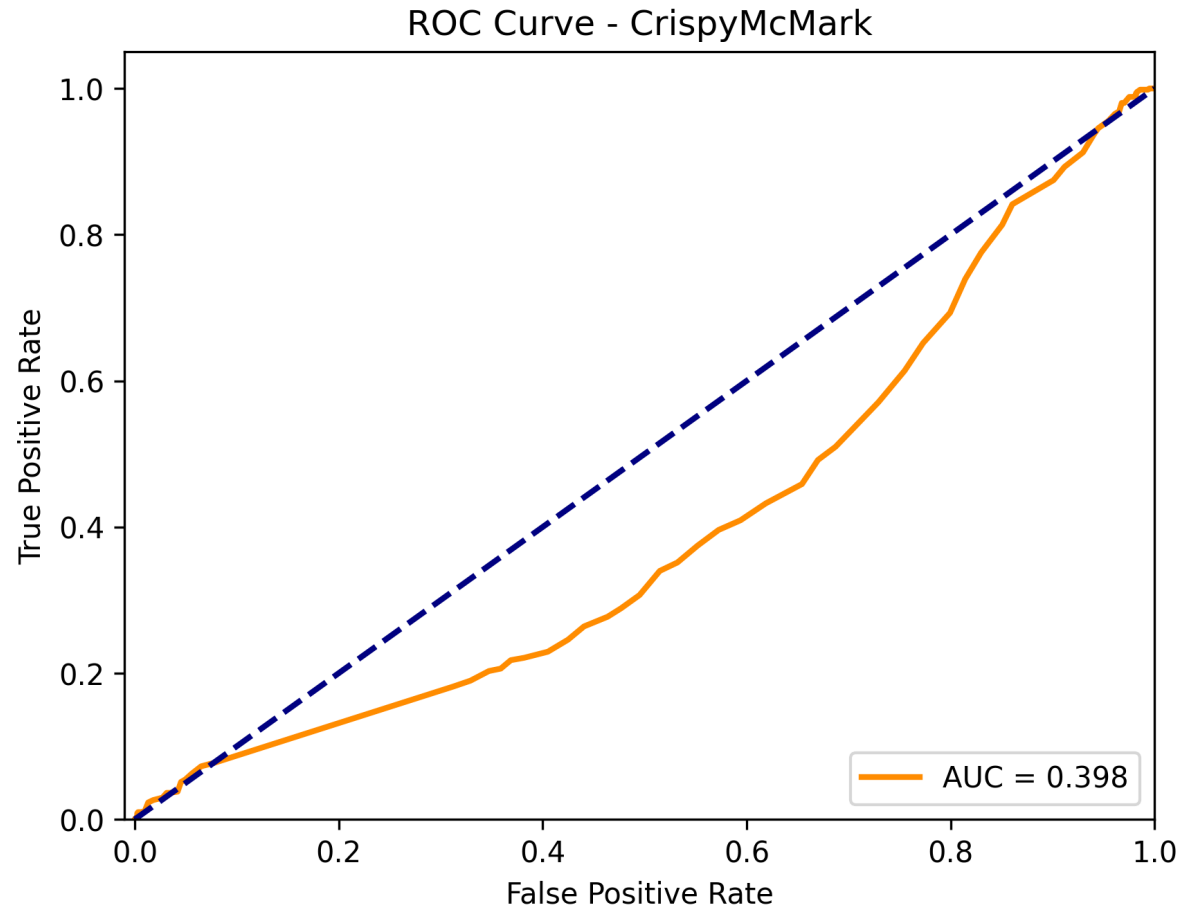


# ROC2



ROC1 + label 0 for original(attacked) images + label 0 for destroyed

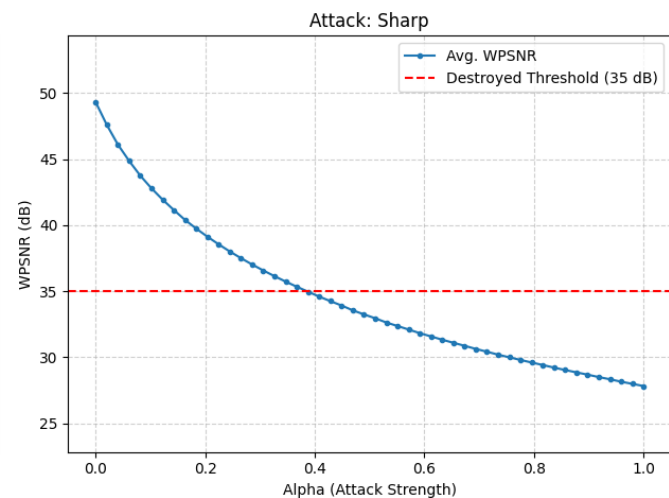
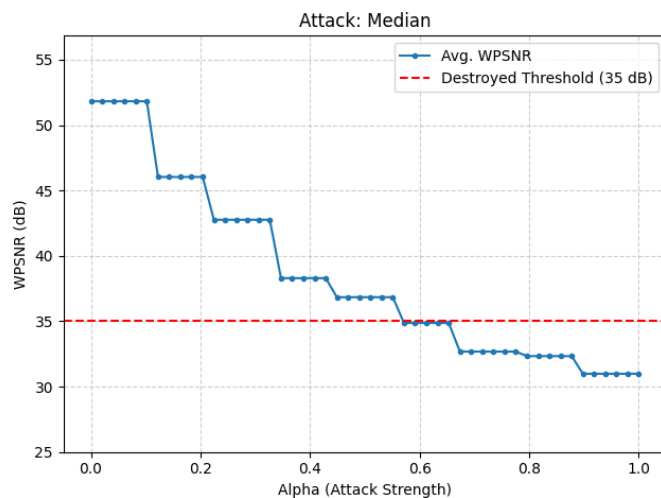
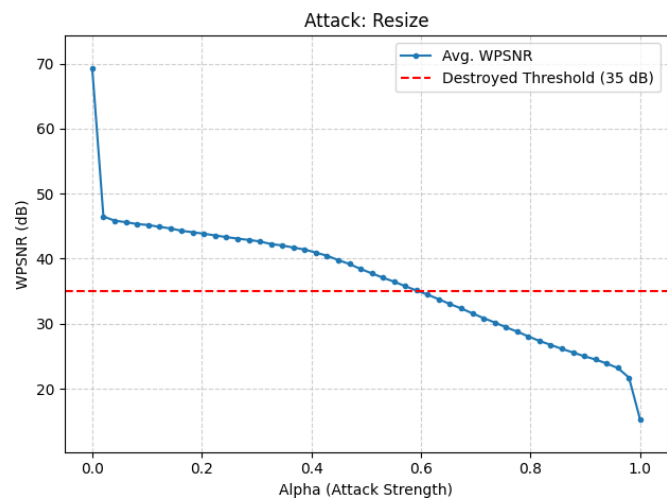
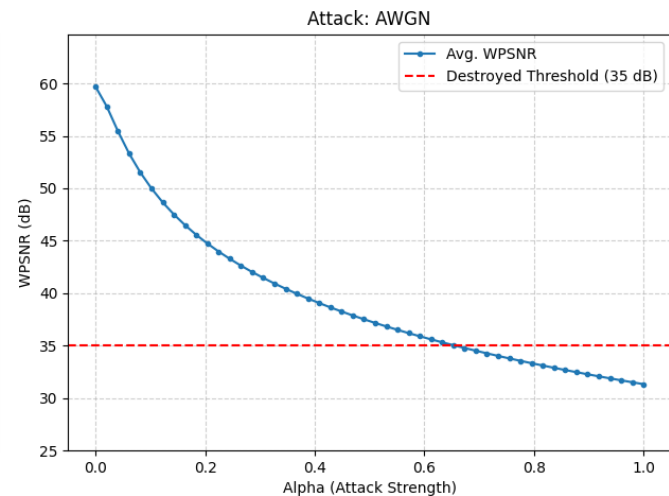
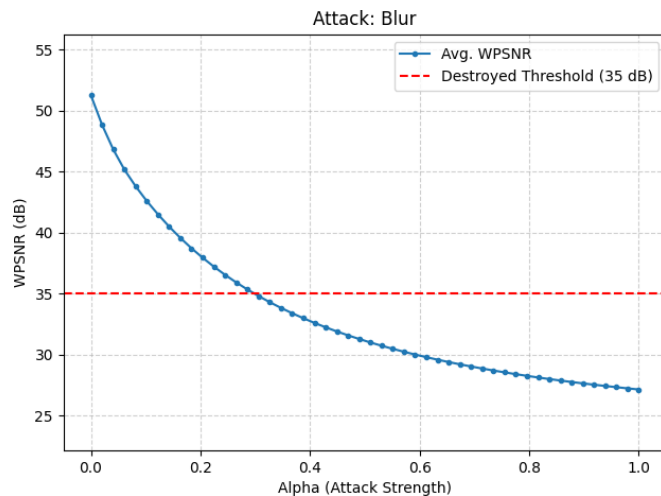
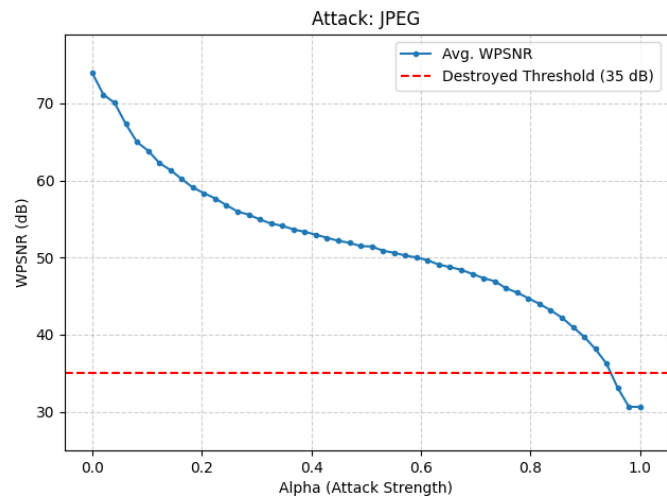
# Effects of hardcoding the watermark



# Attack Strategy

- binary search to find optimal attack strength
- attack functions tweaked to accept parameter  $0 \leq \beta \leq 1$
- use of masks to attack different areas of the image
- parallelization to improve execution speed

# Attack Strategy - binary search



# Attack Strategy - masks

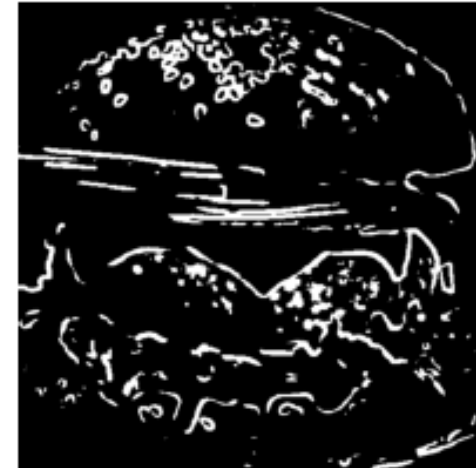
original\_img



edges\_mask



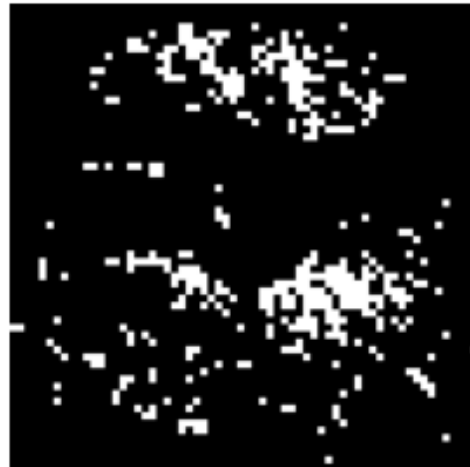
noisy\_mask



attack\_mask



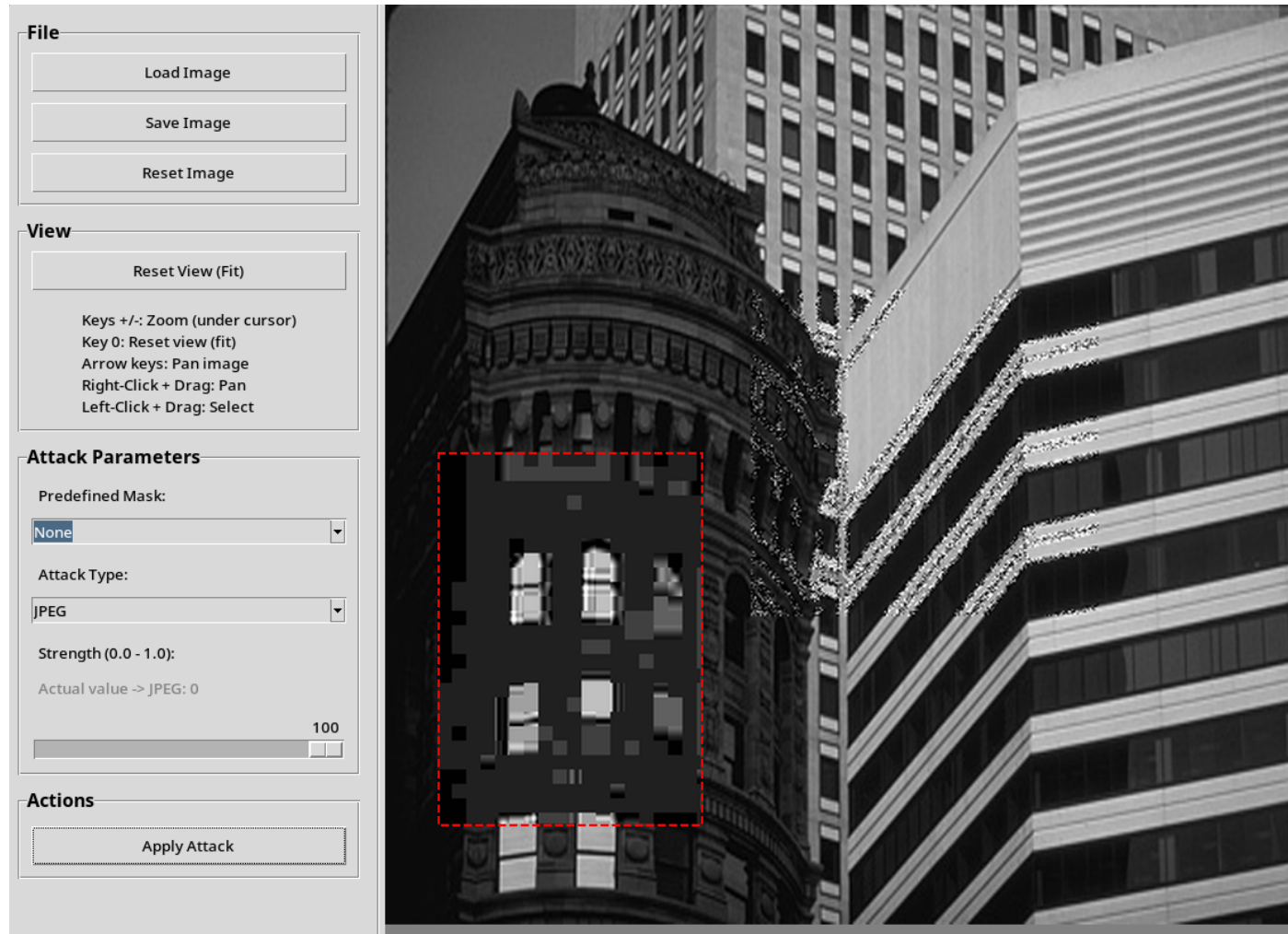
frequency\_mask



saliency\_mask



# Attack Strategy - GUI tool



# Possible Improvements

- Add redundancy based on singular value importance
- Improve the invisibility of attack squares, either by block choice or embedding strength
- explore different embedding techniques on each block

# Questions?

