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# Catch the Mark 2022

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# Embedding

## DWT + SVD

Hybrid strategy based on various researches

## Problems regarding existing papers

Direct usage of the watermark inside the embedding methods

New!

## Novelty

Different **preprocessing method** - based on a "merit"

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# Preprocessing

## Selection of n_blocks_to_embed based on a *"merit"*

Higher merit is given to:

- Blocks least attacked in an attack phase:
    - Blur, median, awgn, sharpening, resizing
- Blocks with higher values of a spatial function

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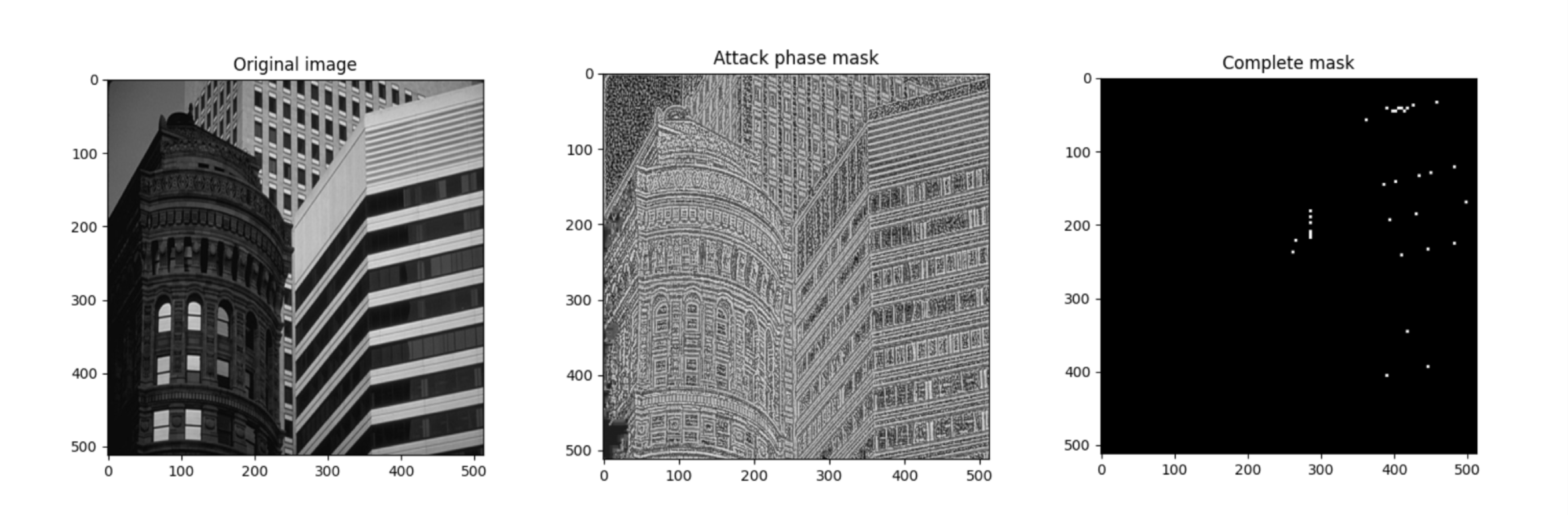
## The reference paper instead used edge detection* ⚠

* "Towards Robust Reference Image Watermarking Using DWT-SVD and Edge Detection"
Satyanarayana Murty. P, Rajesh Kumar. P, 2013

# Novelty

New!

Helpful during the detection phase



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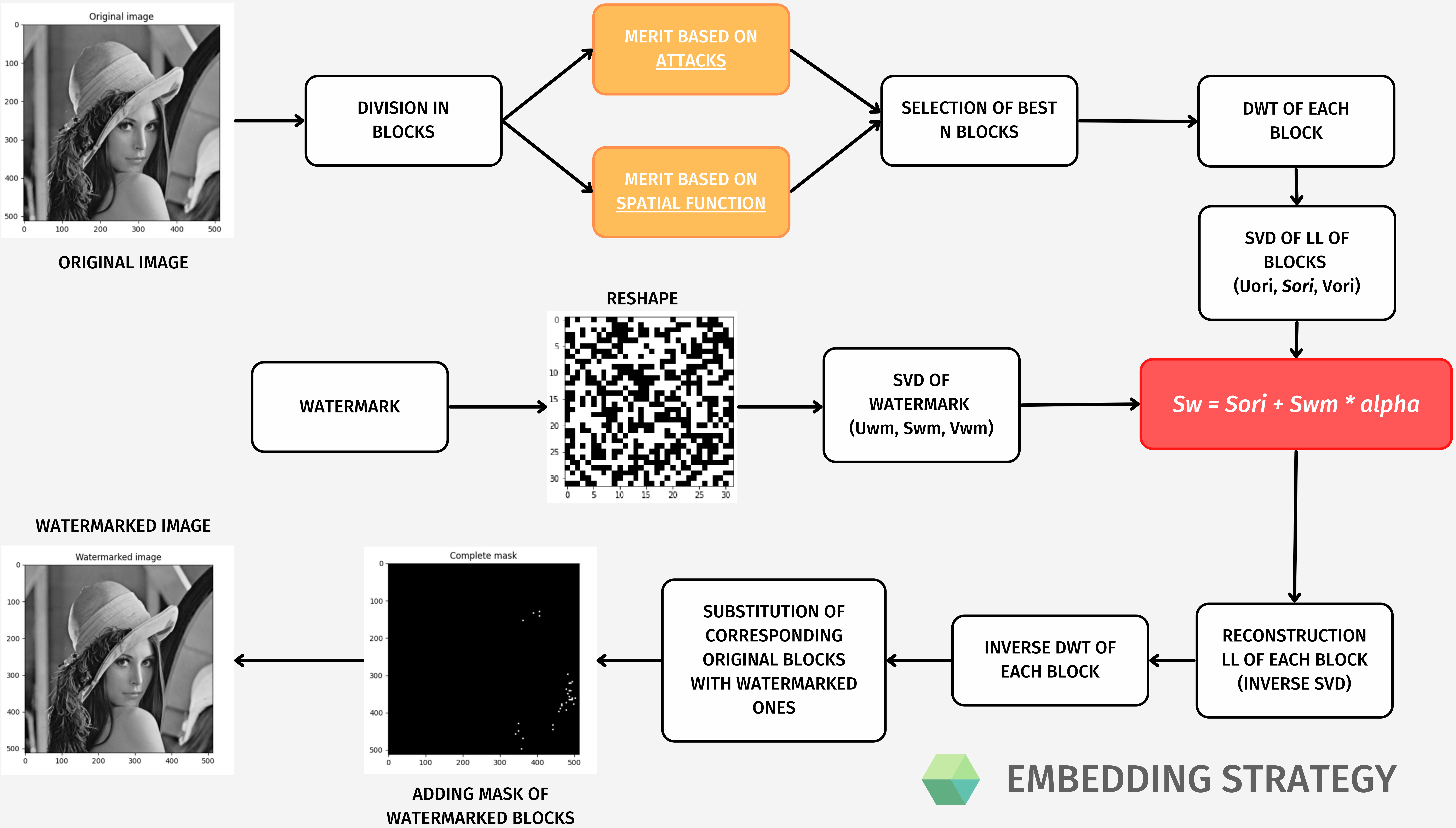
# EMBEDDING STRATEGY



ORIGINAL IMAGE

DIVISION IN BLOCKS

MERIT BASED ON ATTACKS

MERIT BASED ON SPATIAL FUNCTION

SELECTION OF BEST N BLOCKS

DWT OF EACH BLOCK

SVD OF LL OF BLOCKS (Uori, *Sori*, Vori)

WATERMARK

RESHAPE

SVD OF WATERMARK (Uwm, Swm, Vwm)

*Sw = Sori + Swm * alpha*

RECONSTRUCTION LL OF EACH BLOCK (INVERSE SVD)

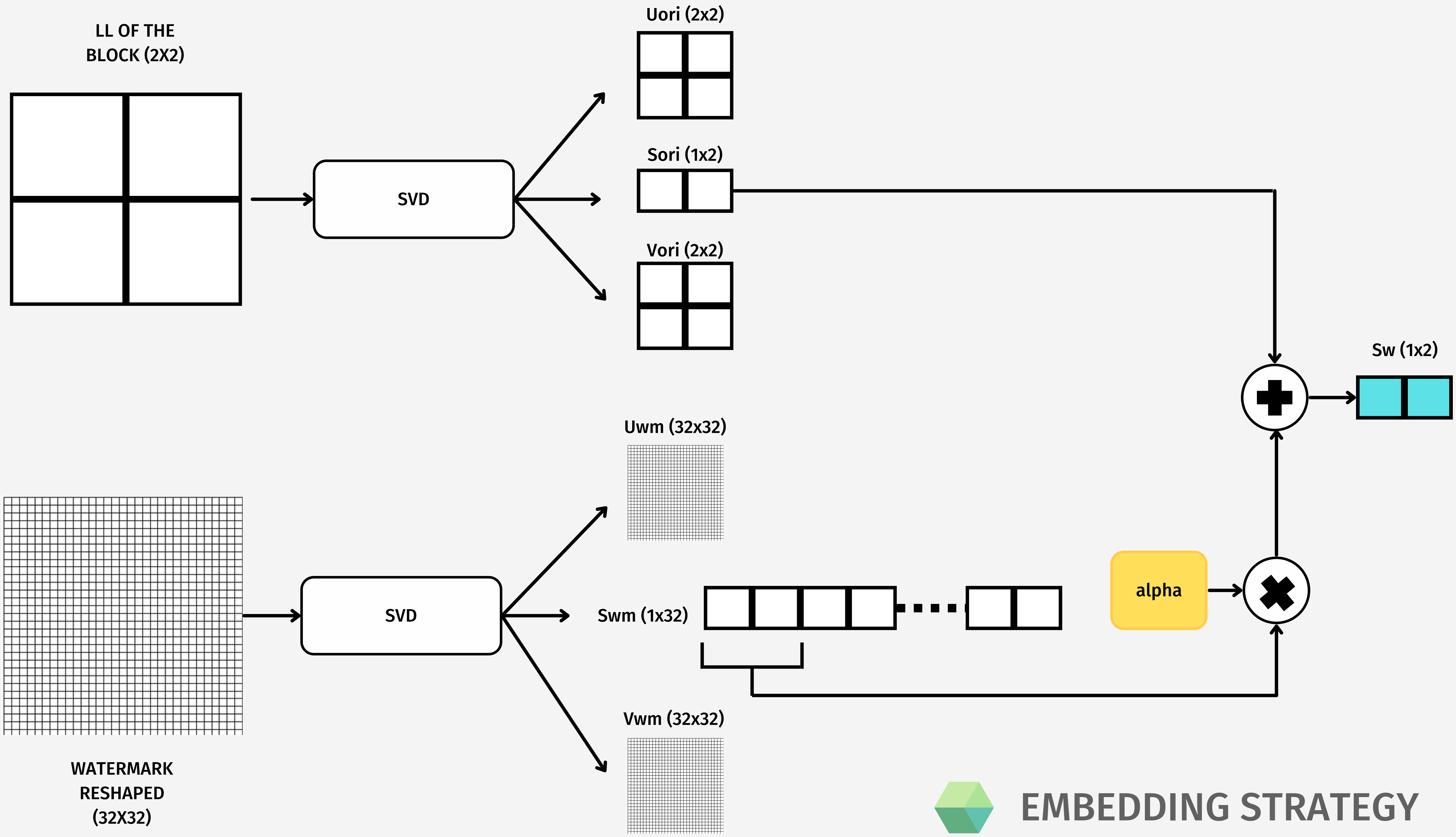
INVERSE DWT OF EACH BLOCK

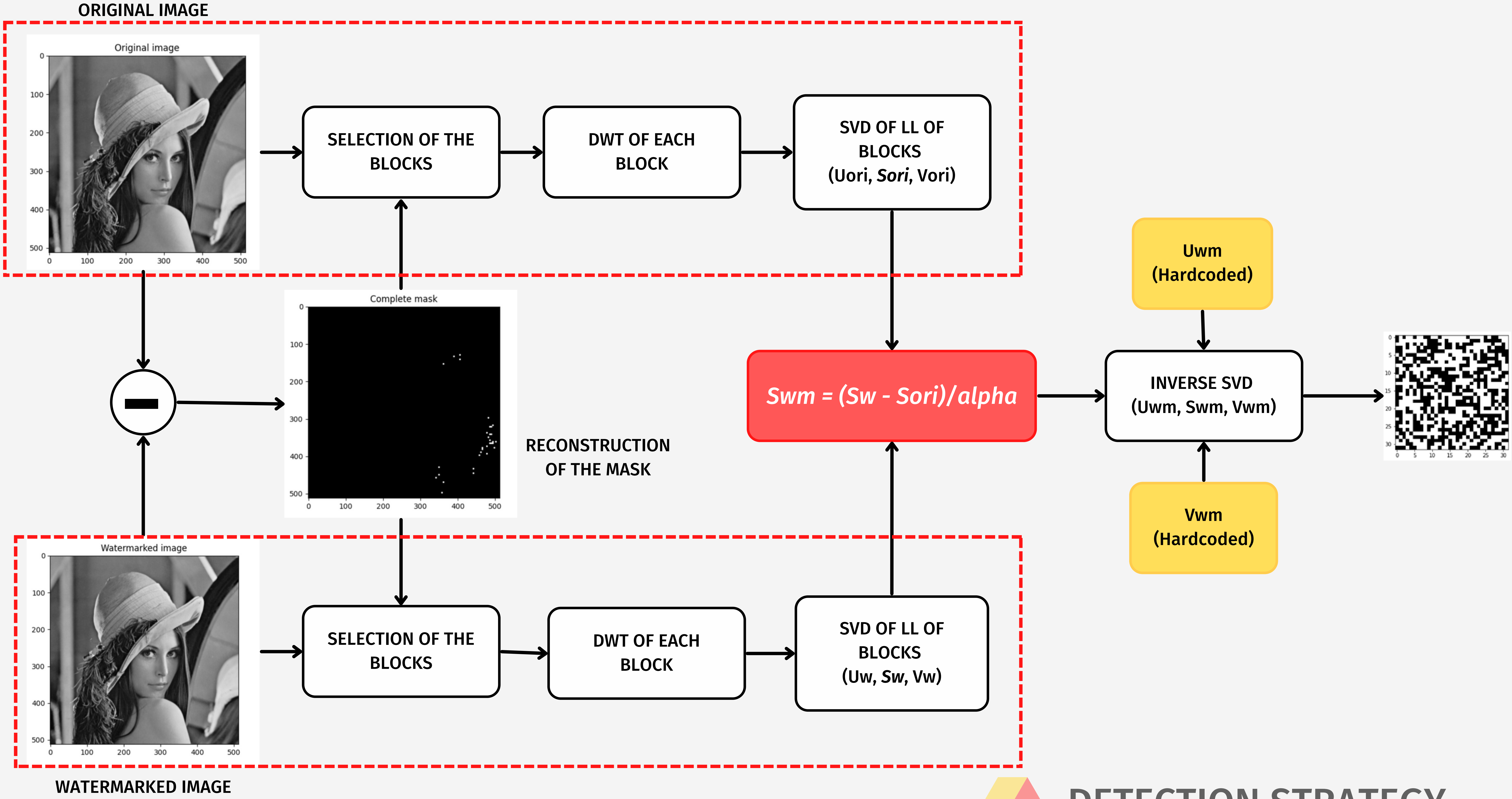
SUBSTITUTION OF CORRESPONDING ORIGINAL BLOCKS WITH WATERMARKED ONES

ADDING MASK OF WATERMARKED BLOCKS

WATERMARKED IMAGE

# EMBEDDING STRATEGY





ORIGINAL IMAGE

SELECTION OF THE BLOCKS

DWT OF EACH BLOCK

SVD OF LL OF BLOCKS
(Uori, *Sori*, Vori)

RECONSTRUCTION OF THE MASK

*Swm = (Sw - Sori)/alpha*

Uwm
(Hardcoded)

INVERSE SVD
(Uwm, Swm, Vwm)

Vwm
(Hardcoded)

SELECTION OF THE BLOCKS

DWT OF EACH BLOCK

SVD OF LL OF BLOCKS
(Uw, *Sw*, Vw)

WATERMARKED IMAGE

# DETECTION STRATEGY

# During the challenge

## Precomputation of multiple thresholds (fpr 6.5%)

We have chosen the parameters that gave at least 66.00db and no more than 66.10db in all 3 images and succeeded in passing the detection test.

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## Parameters we focused on:

- Alpha
- n_blocks_to_embed (16, 32, 64)
- Weights given to calculate the merit:
    - Spatial function
    - Attack phase

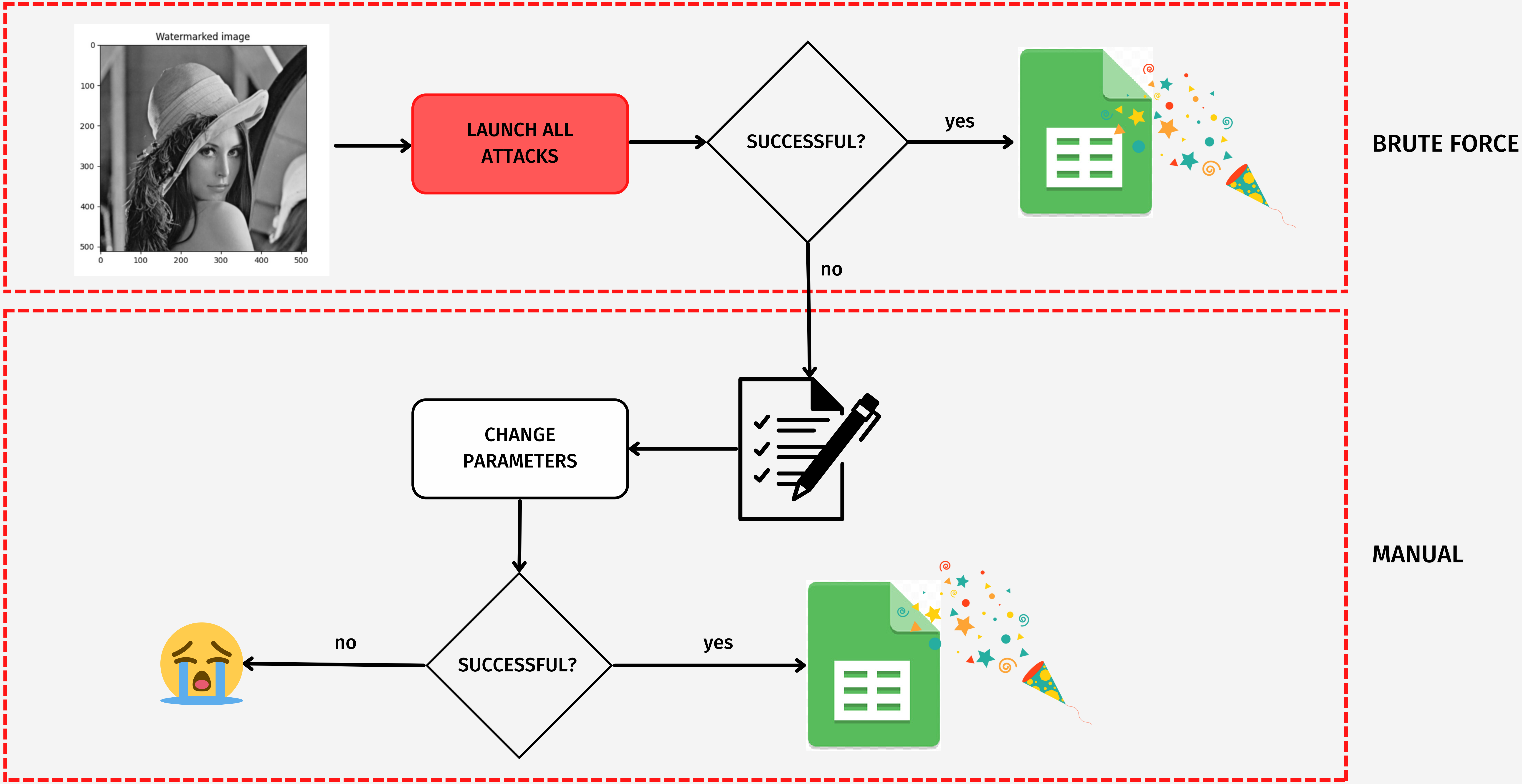
# Attacks

## Brute force attacks

WPSNR > 35 and mark removal

## Manual attacks

Change pre-set parameters



LAUNCH ALL ATTACKS

SUCCESSFUL?

yes

no

BRUTE FORCE

CHANGE PARAMETERS

SUCCESSFUL?

no

yes

MANUAL

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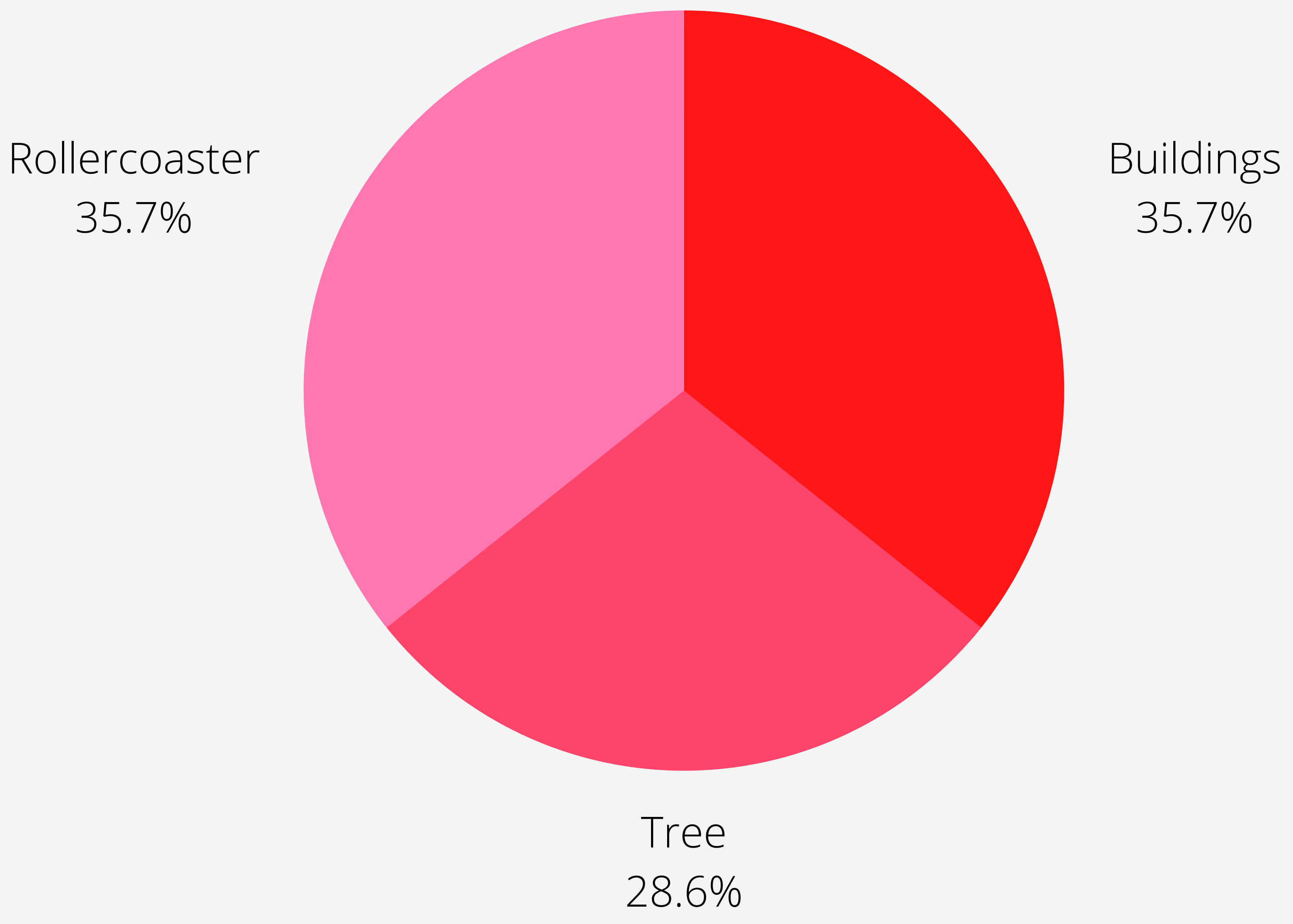
# Attacks' results

## Attacked images



Average time to attack a group: **15 min**

Parallelization with multiple users/pc

✓ Groups successfully attacked: **100%**

✓ Images successfully attacked: **93,3%**

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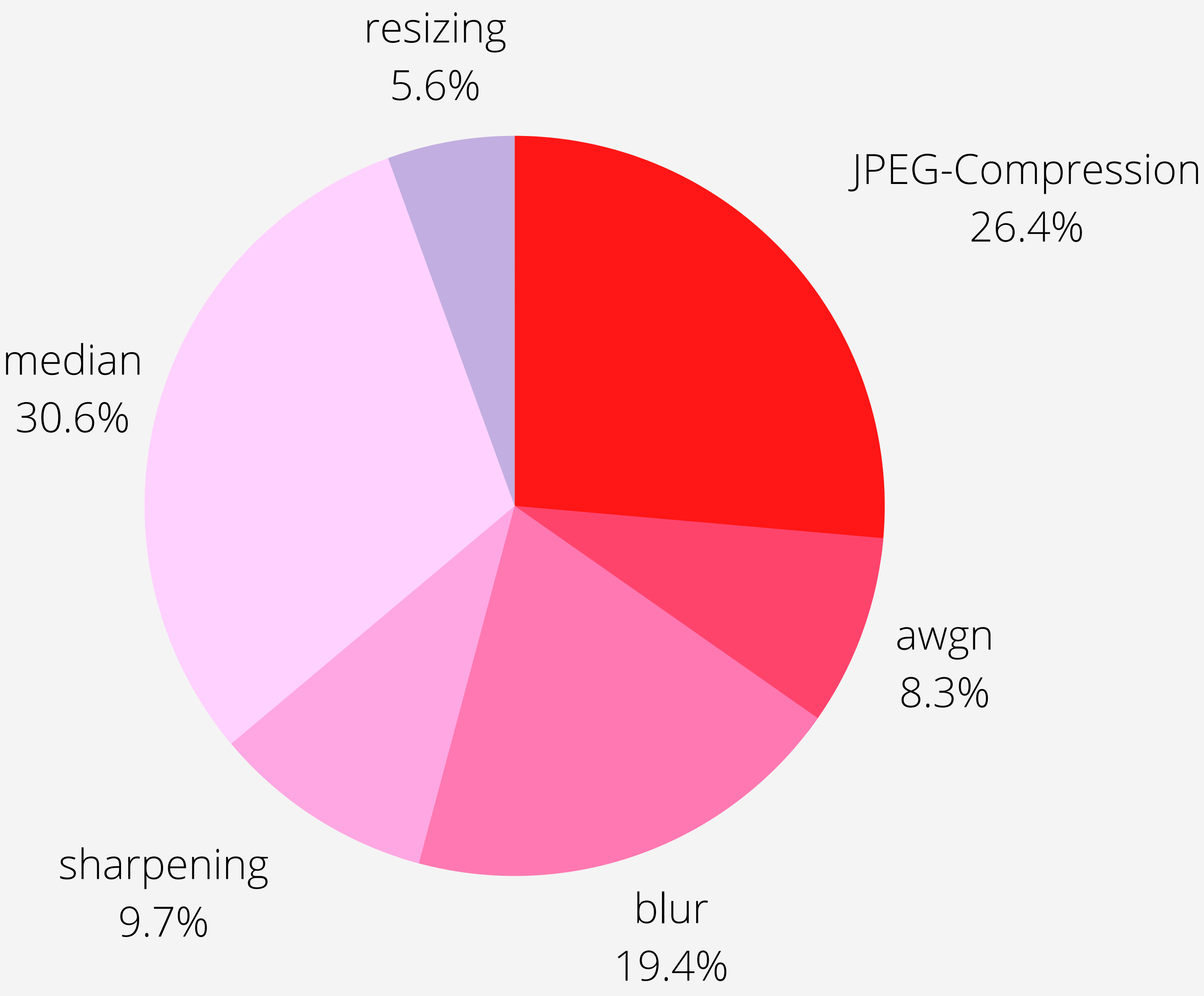
# Attacks' results

## Best attacks



| Statistic | WPSNR |
|---|---|
| average | 41,89 |
| min | 36,51 |
| max | 59,11 |

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how i met your ~~mother~~ mark