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# Discrete fractional watermark technique

**Key words:** Discrete fractional calculus; Image encryption; Watermark

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# Motivation

- Watermark is often used to protect the copyright of images and chips against clone products.
- In discrete fractional calculus (DFC), finite sum is used for fractional operators. In comparison with classical fractional calculus, we can implemet a watermark with less computatonal cost and better accuracy.
- Discrete memory effects were successfully introduced in standard logistic maps and rich dynamics was obtained. It can be concluded that DFC provides an exact discrete-time method without loss of memory.

# Main idea

- Using a fractional logistic map, we generate chaotic series. We obtain an encryption watermark where the fractional order is used as a key.

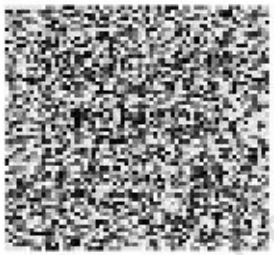
- To decrypt the image, we first extract the encrypted watermark. Then, using the keys which include the fractional order, we can obtain the watermark image.

# Method

1. Encrypt the watermark image *W* using the logistic chaotic series and obtain an encryption image *W**.
2. Add watermark image *W** to the original image *P* to obtain watermark result *R*.
3. Extract *W** from *R* to decrypt the image and compare the decrypted image *W** with the original one *W*.

# Major results

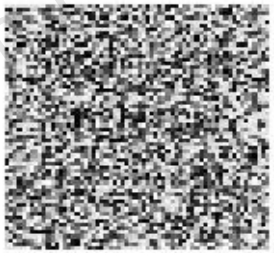

(a) Image W



(b) Encryption of W

(c) Lena

(d) Watermark result



(e) Extraction of the image W*


(f) Decrypted result

**Discrete fractional watermark technique**

# Conclusions

- Discrete fractional calculus provides more keys to increase the key space and improve the security of watermark.
- The results show that it is a powerful watermark technique.
- Discrete fractional calculus provides an exact discretization method and is suitable for image processing.