

A Visible Watermarking Chip for A Secure Digital Still Camera (S²DC)

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Outline of the Talk

- What is digital watermarking ?
- Why watermarking ?
- Some similar terms
- Types of watermarking
- General framework for watermarking
- Watermarking : Attacks
- Visible watermarking : My work
- Watermarking chip : Proposal
- Conclusions

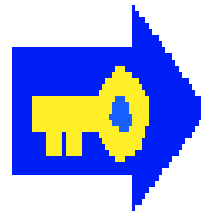
Digital Watermarking ?

Digital watermarking is defined as a process of embedding **data** (watermark) into a multimedia **object** to help to protect the owner's right to that object. The embedded data (watermark) may be either *visible* or *invisible*.

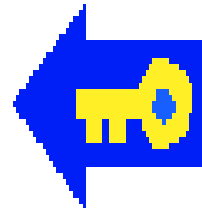
Some Examples Watermarked Images



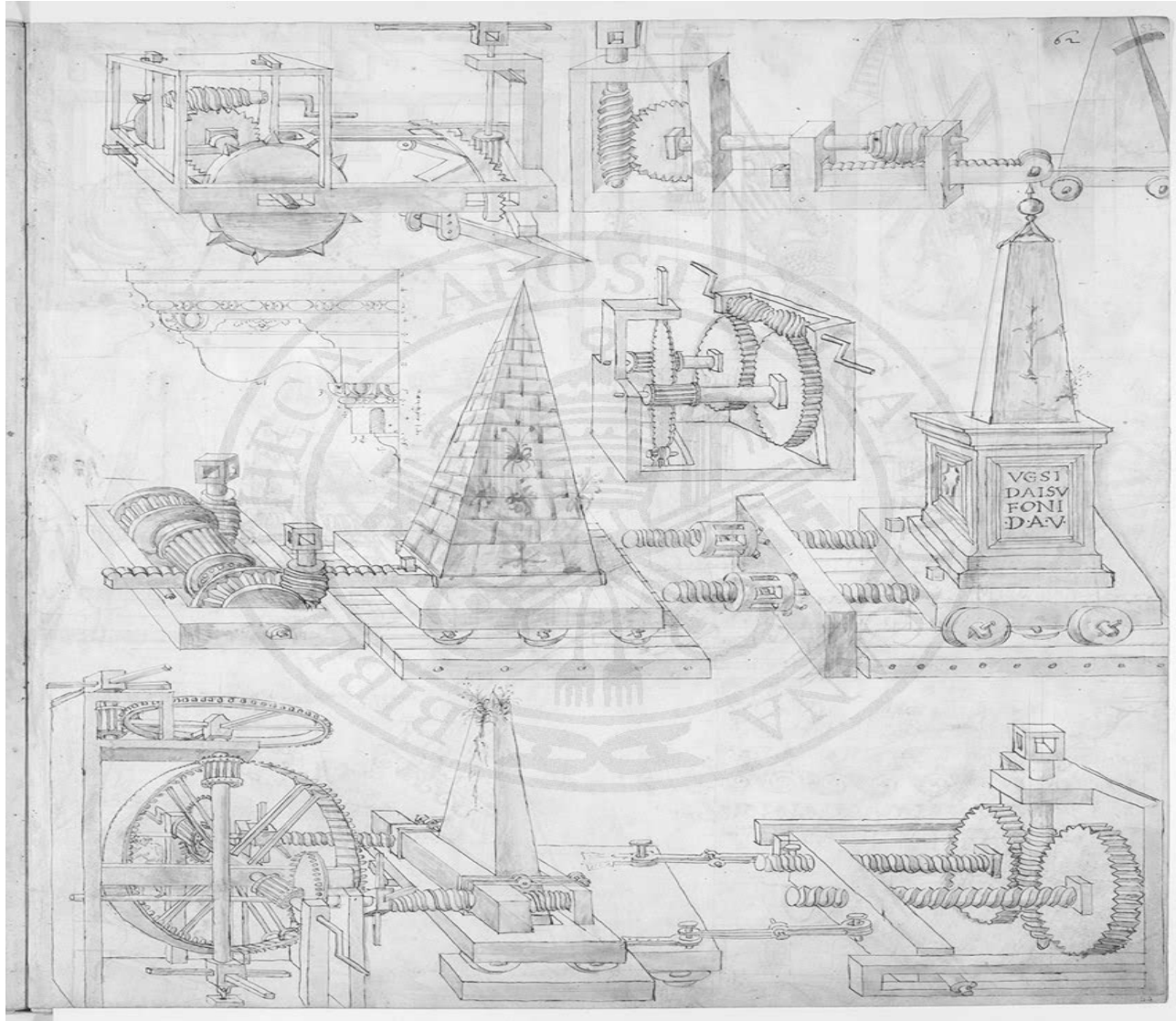
Embed



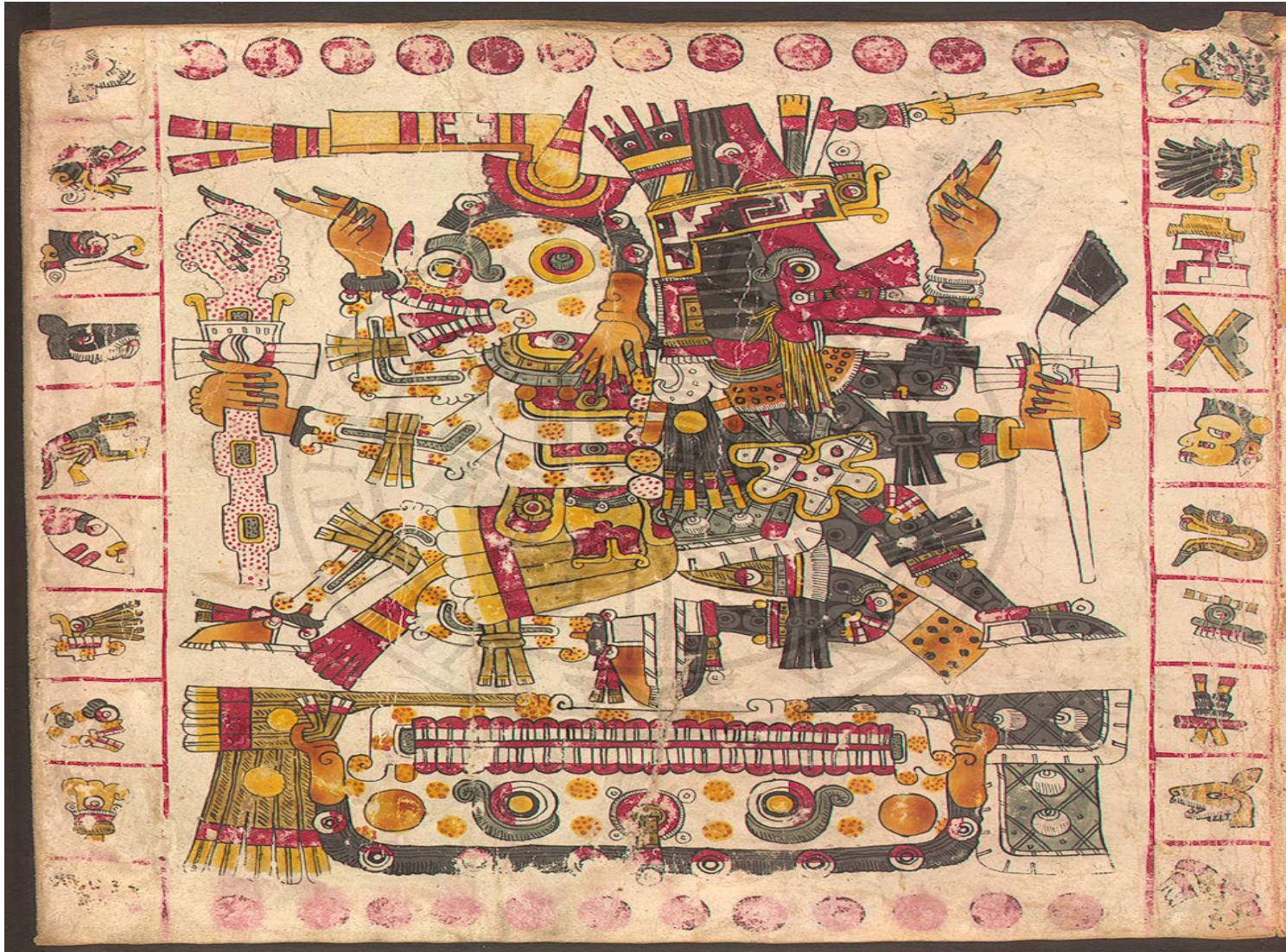
Remove



Some Examples



Some Examples



Cryptography Vs Steganography

Cryptography : Secret writing

Steganography : Cover writing

Steganography Vs Watermarking

Steganography : Bandwidth

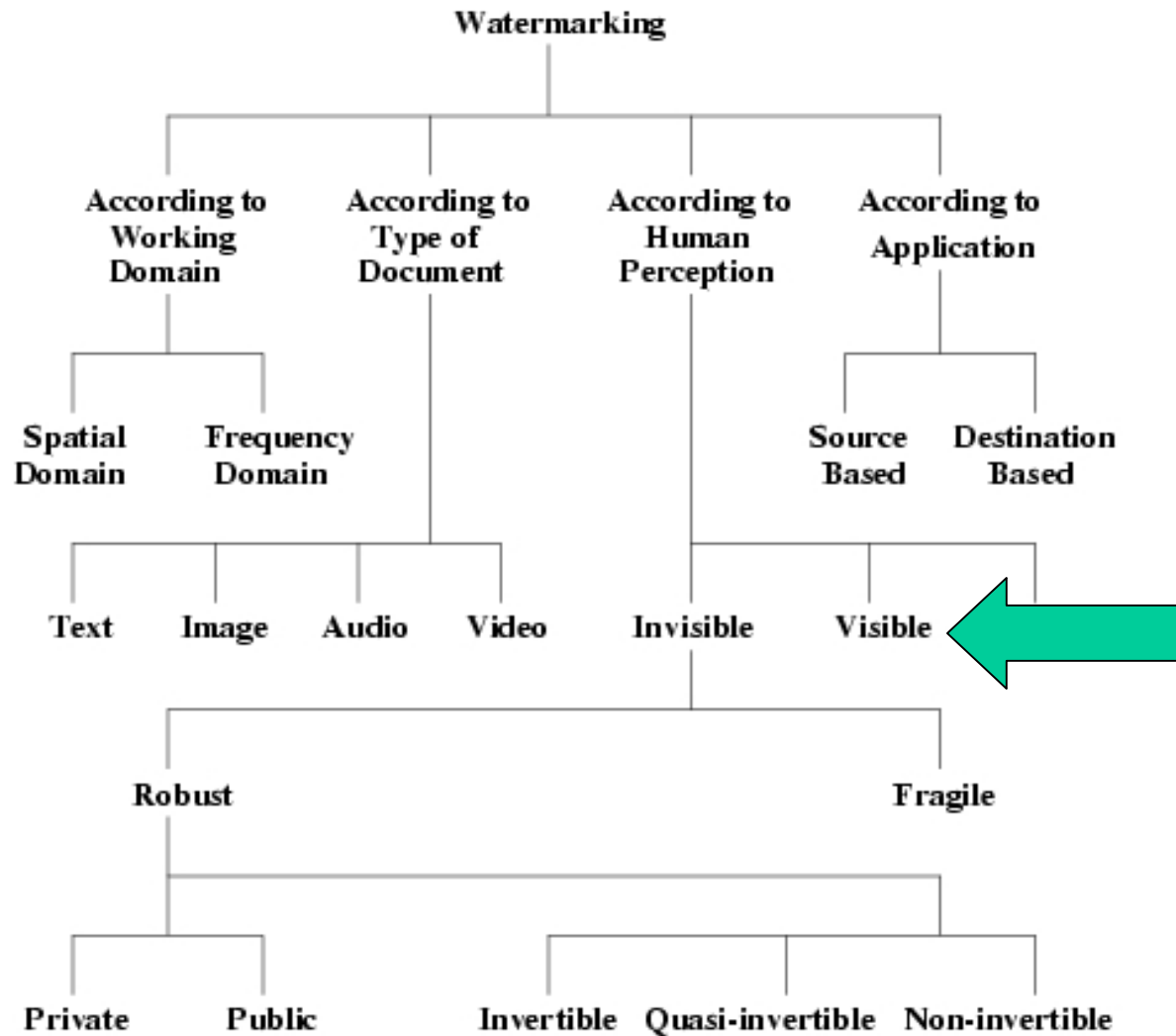
Watermarking : Robustness

IP Protection Vs Copyright Protection

Intellectual property : protection of processor **core**

Copyright : protection of **data**

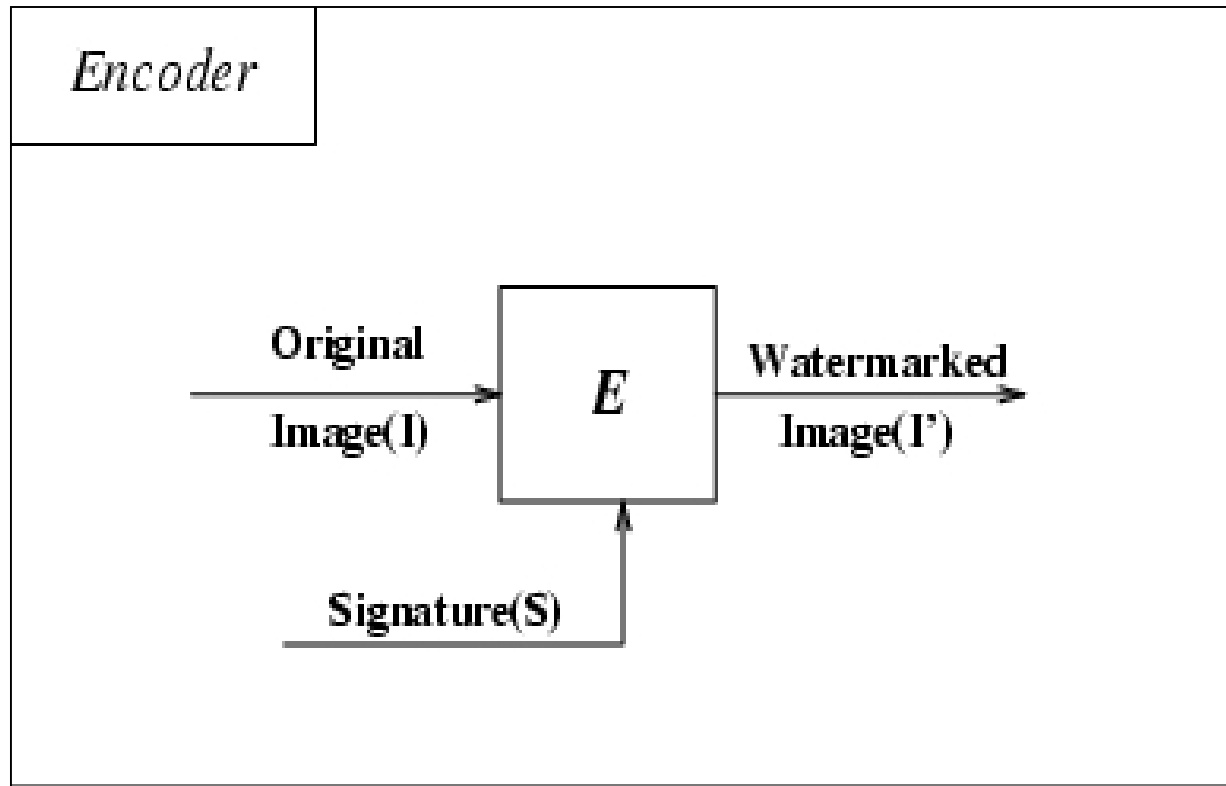
Types of Watermarking Techniques



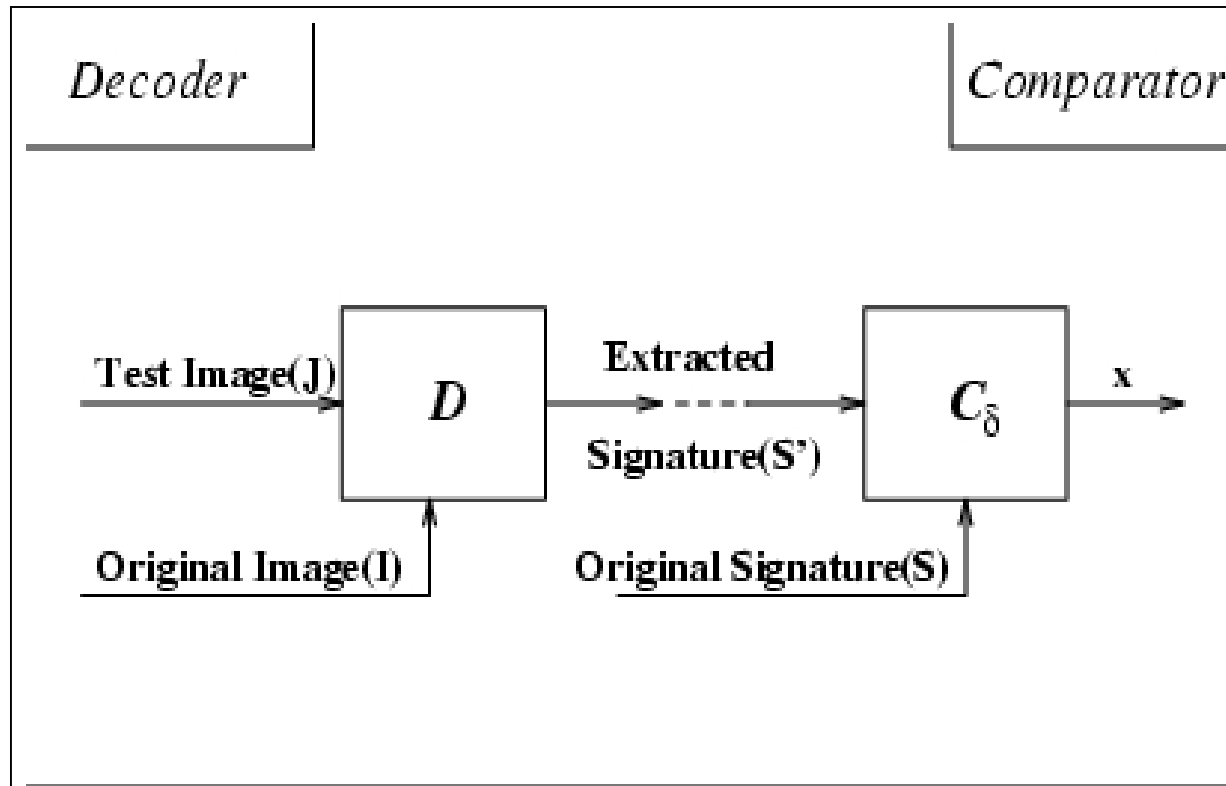
Watermarking : General Framework

- Encoder
- Decoder
- Comparator

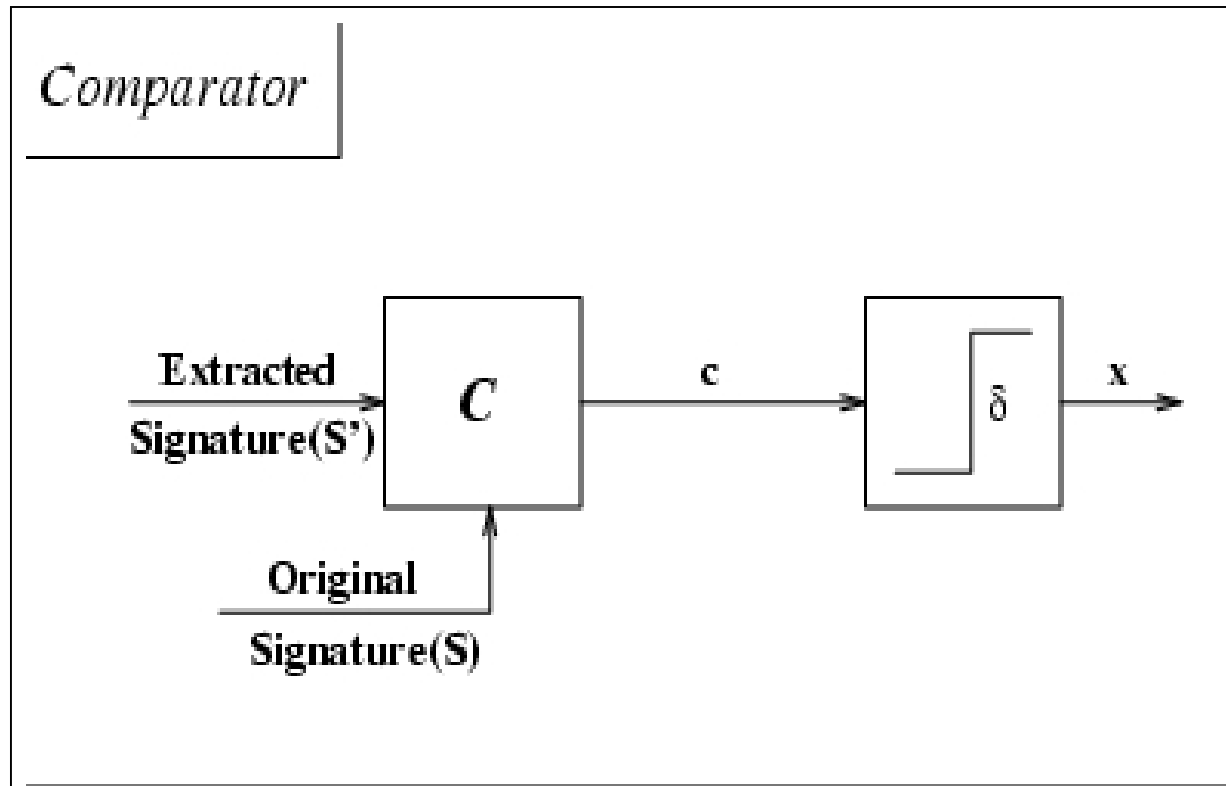
General Framework : Encoder



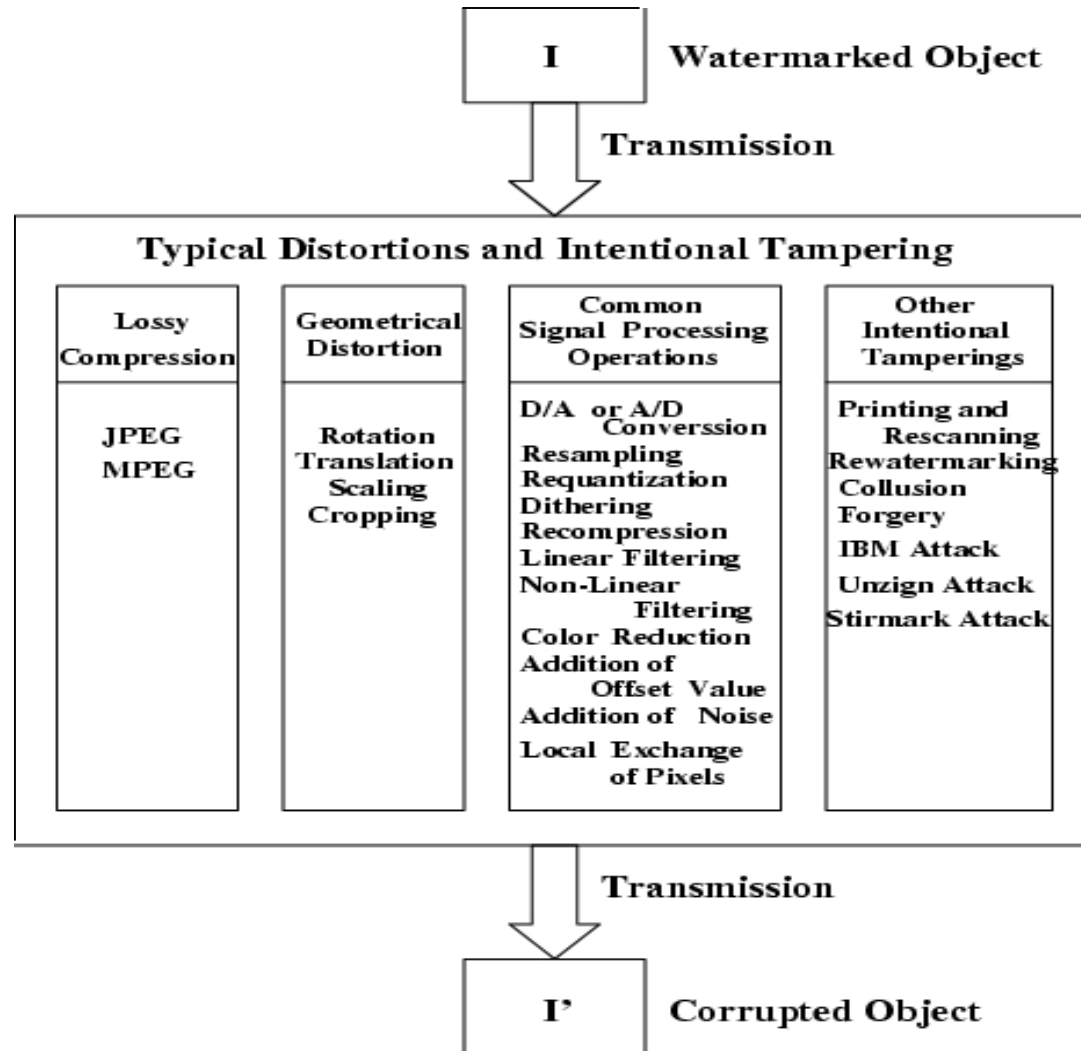
General Framework : Decoder



General Framework : Comparator



Attacks on Watermark



What is Visible Watermarking ?

In visible watermarking of images, a secondary image (the watermark) is embedded in a primary (host) image such that watermark is **intentionally perceptible** to a human observer.

Visible Watermarks: Desired Characteristics

- A visible watermark should be obvious in both color and monochrome images.
- The watermark should be spread in a large or important area of the image in order to prevent its deletion by clipping.
- The watermark should be visible yet must not significantly obscure the image details beneath it.
- The watermark must be difficult to remove; removing a watermark should be more costly and labor intensive than purchasing the image from the owner.

Visible Watermarking : My work

- Let $c_{ij}(n)$ are the DCT coefficients of the host image block and $w_{ij}(n)$ the DCT coefficients of the watermark image block.
- The DCT coefficients of the Watermarked image are then obtained as follows :

$$c'_{ij}(n) = \alpha_n c_{ij}(n) + \beta_n w_{ij}(n) \quad n = 1, 2, \dots$$

- The α_n and β_n are scaling and embedding factors for block n respectively.

Factors considered to maintain Image Quality

- The **edge** blocks should be least altered to avoid significant distortion of the image.
- The distortion visibility is low when the background has strong **texture**.
- The blocks with **mid-intensity** values ($\mu_n \approx \mu$) are more sensitive to noise than that of low intensity blocks ($\mu_n < \mu$) as well as high intensity blocks ($\mu_n > \mu$).

Finding Scaling and Embedding Factors

- The α_n and β_n for **edge** blocks are taken to be $\alpha_{\max}$ and $\beta_{\min}$ respectively.
- For **non-edge** blocks α_n and β_n are computed as:

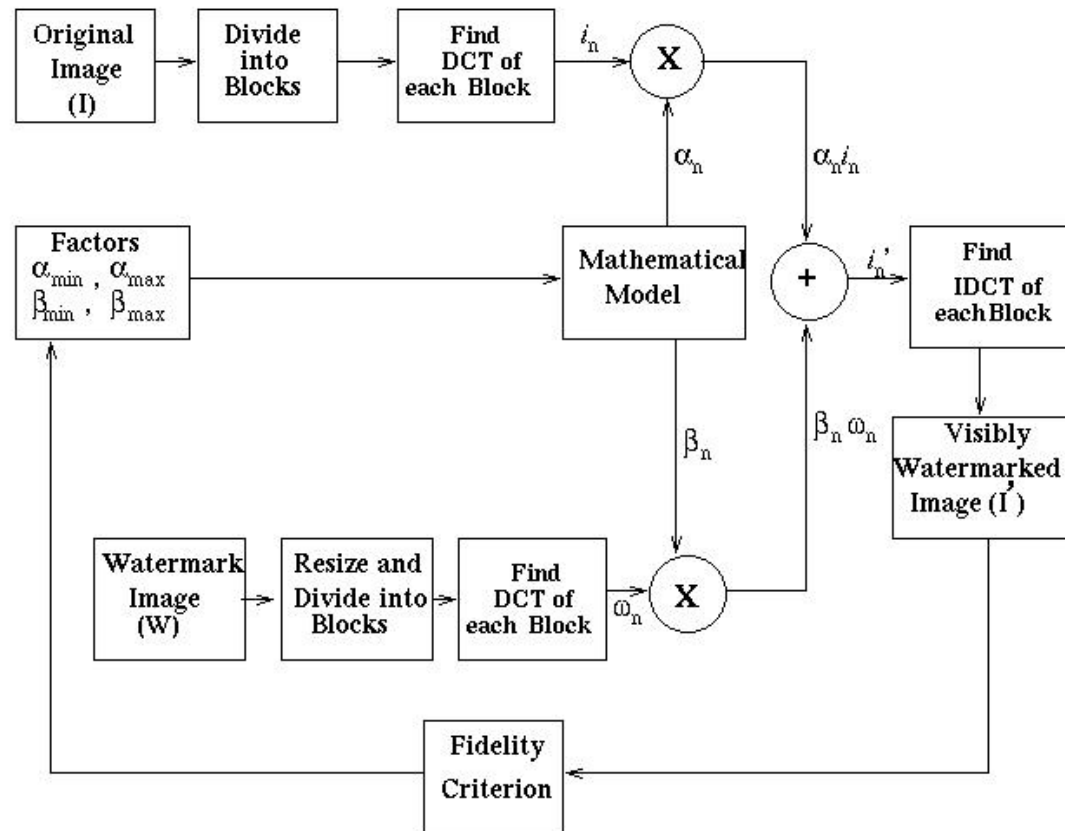
$$\alpha_n = \sigma'_n \exp. (- (\mu'_n - \mu')^2)$$

$$\beta_n = (1/\sigma'_n) (1 - \exp. (- (\mu'_n - \mu')^2))$$

where, μ'_n , μ' are the normalized values of μ_n and μ respectively, and σ'_n is normalized logarithm of σ_n (the variance of the AC DCT coefficients).

- α_n and β_n are then scaled to the ranges $(\alpha_{\min}, \alpha_{\max})$ and $(\beta_{\min}, \beta_{\max})$ respectively, where $\alpha_{\min}$ and $\alpha_{\max}$ are the minimum and maximum values of the scaling factor, and $\beta_{\min}$ and $\beta_{\max}$ are the minimum and maximum values of the embedding factor.

Insertion of Visible Watermark



Host and Watermark Images



Host Image



Watermark Image

Watermarked Images



Watermark over
the whole image



Small Watermark at
a corner

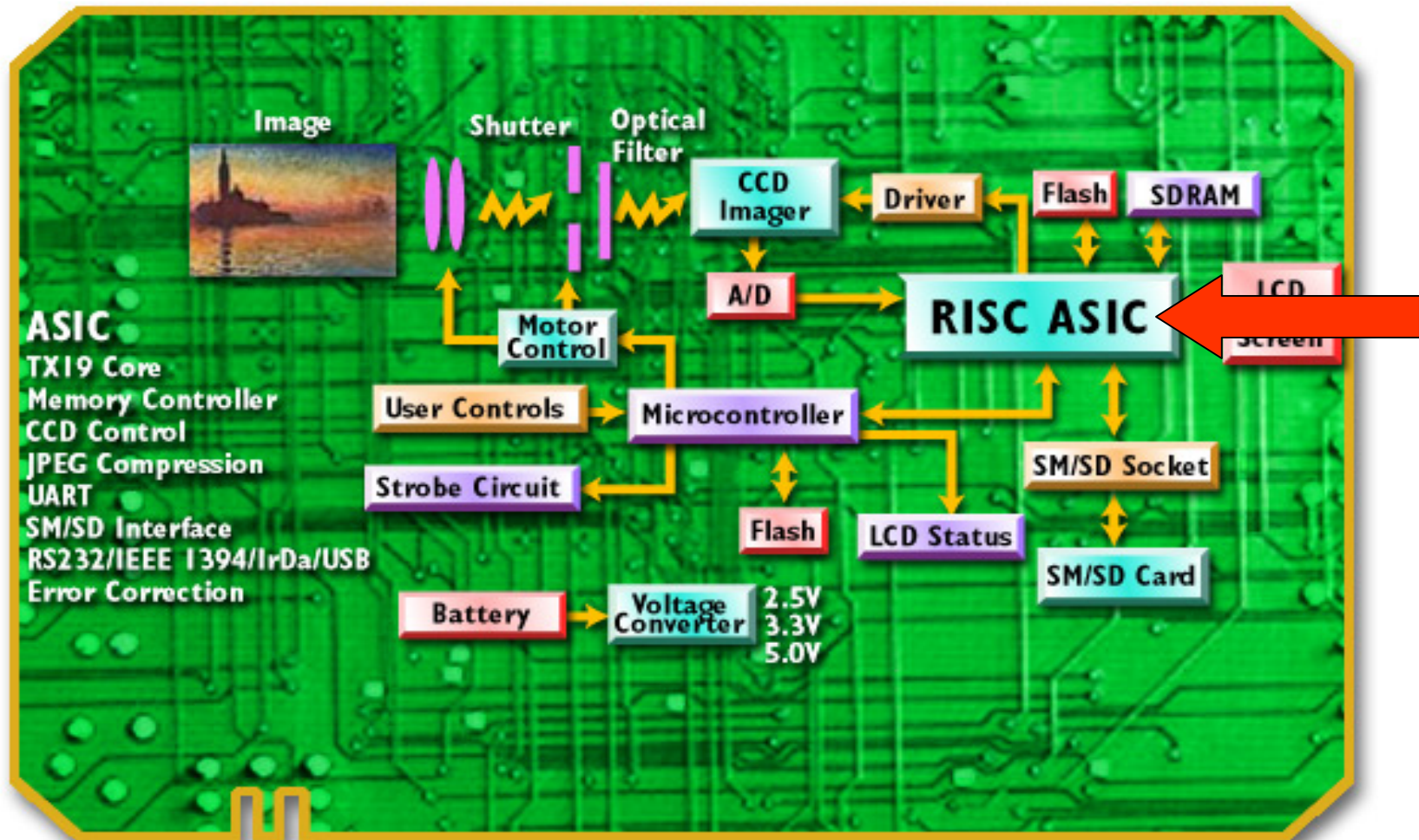
Source of Digital Pictures (Images)

- ❖ Digital camera
- ❖ Scanner / Digitizer
- ❖ Web cam
- ❖ Camcorder

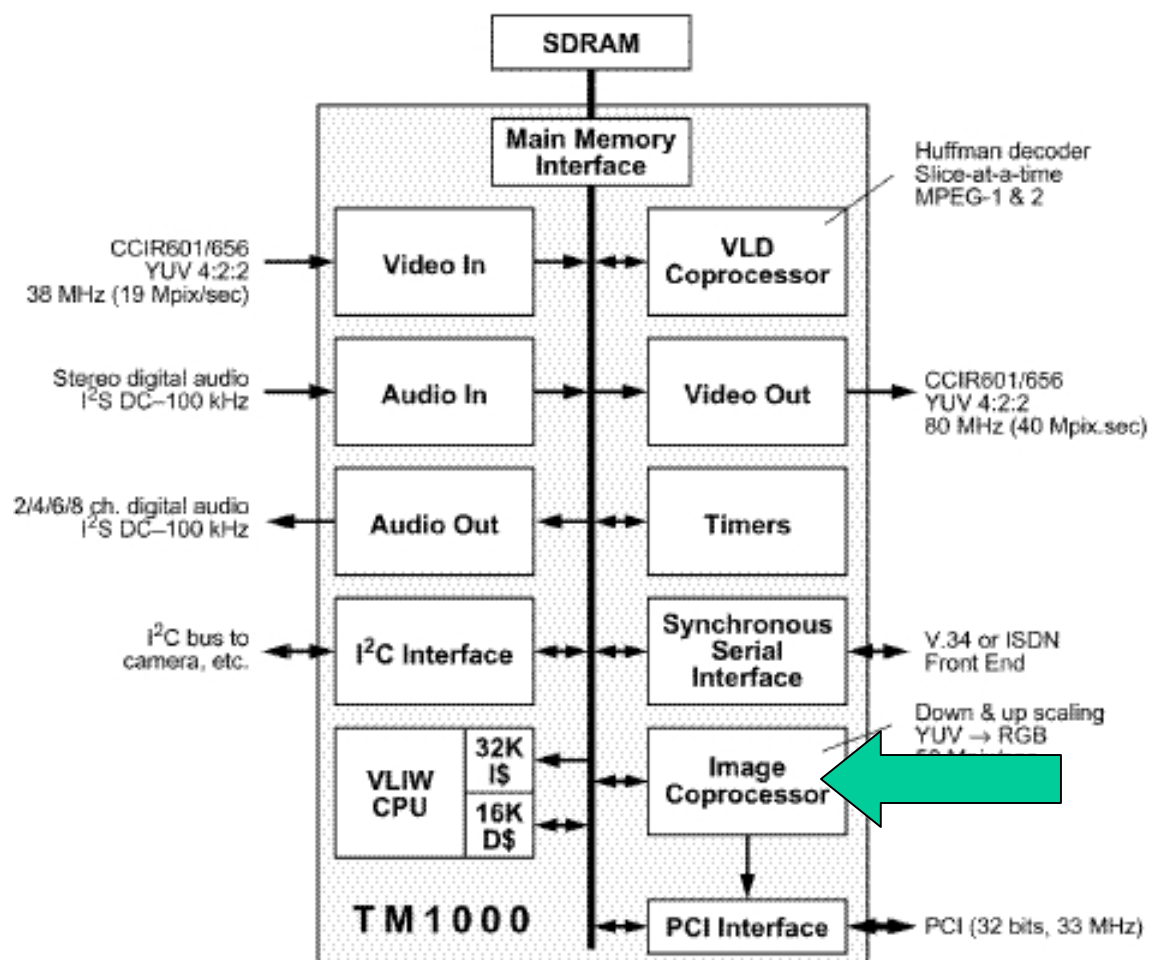
Use of Visible Watermark

- ❖ Still image
- ❖ VCD
- ❖ DVD
- ❖ Digital TV broadcasting
- ❖ Digital Library

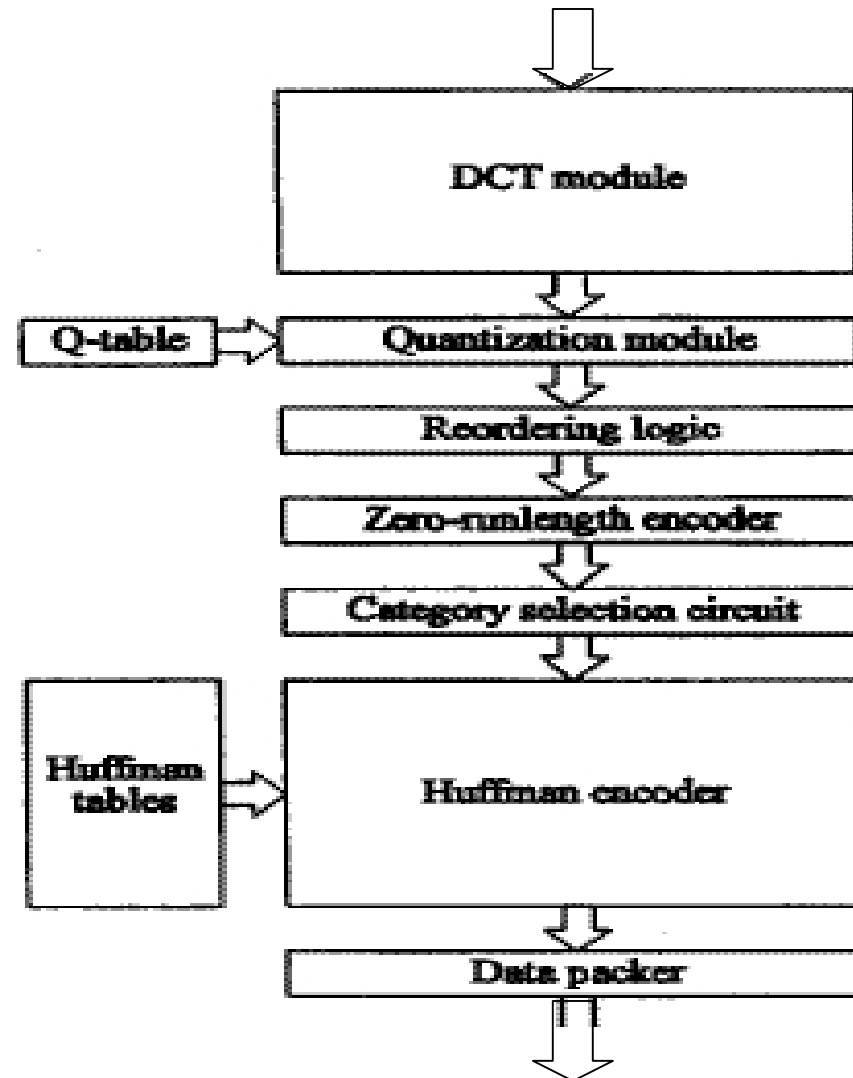
Digital Camera



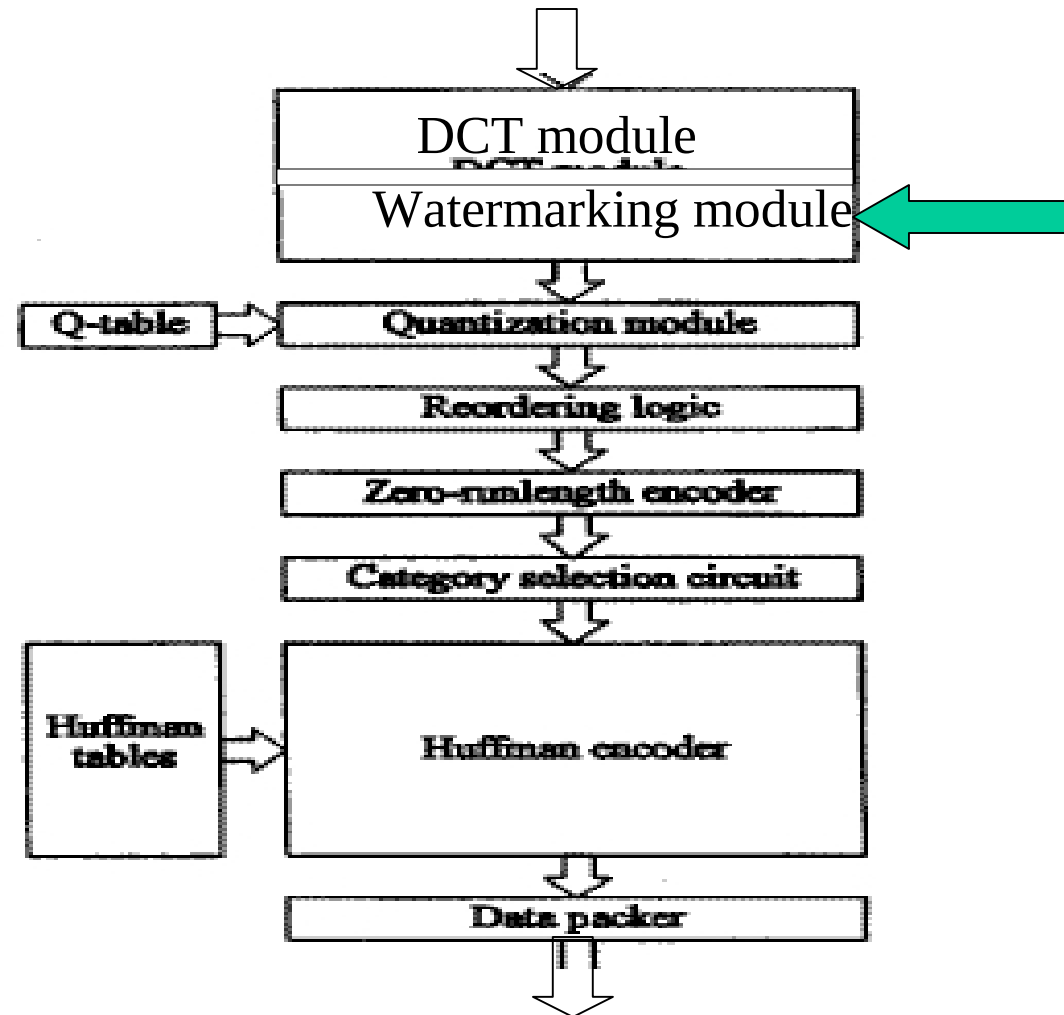
Media Processor : conceptual view



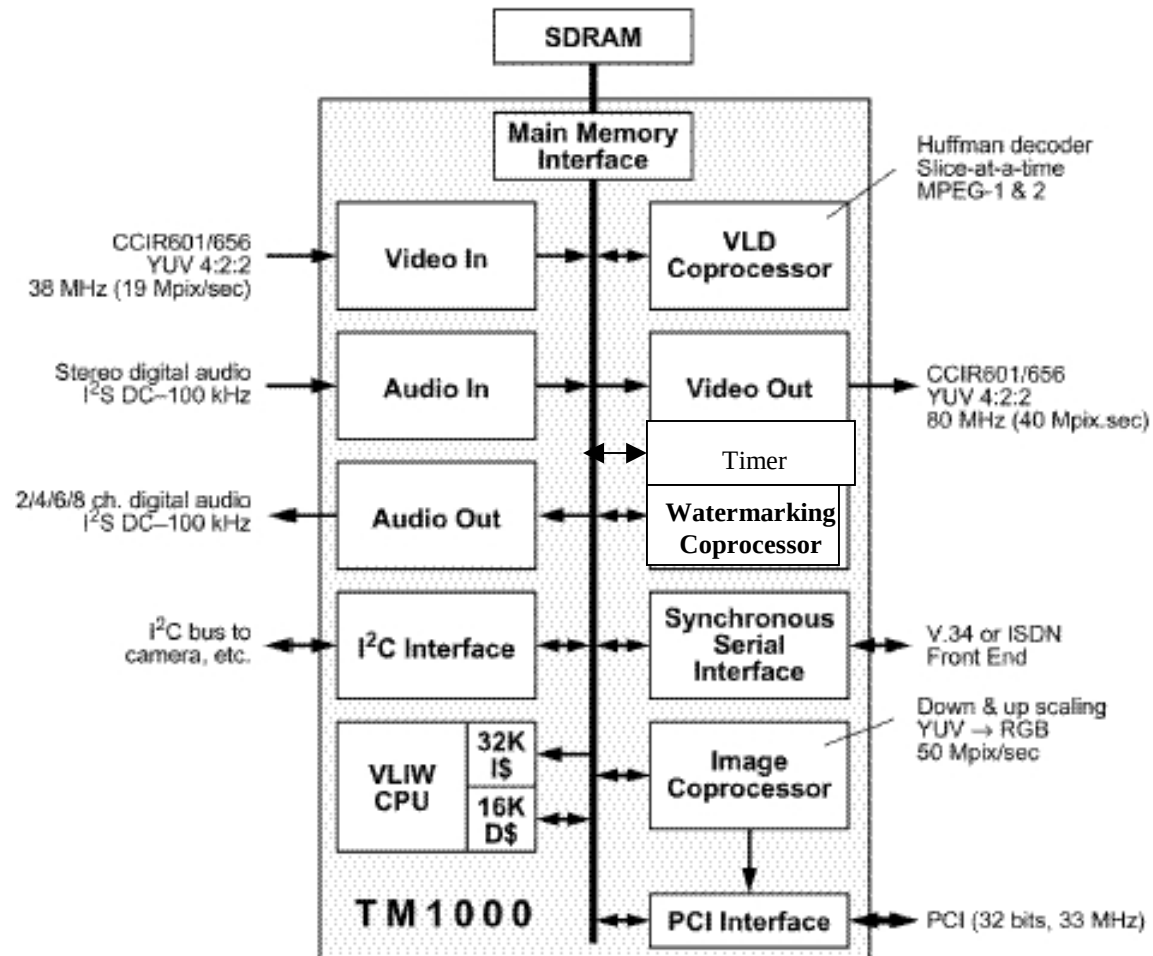
JAGUAR : Architecural view



JAGUAR: for secure digital still camera (S²DC)



Watermarking Co-processor : for S²DC



Conclusions

- Fundamentals of digital watermarking
- A visible watermarking technique in detail
- Applications of visible watermarking
- Digital camera
- Signal processor
- Modifying Co-processor for secure camera
- A visible Watermarking chip
- More watermarking chip designs possible

Thank you