INTERNATIONAL ORGANISATION FOR STANDARDISATION
ORGANISATION INTERNATIONALE DE NORMALISATION
ISO/IEC JTC1/SC29/WG11
CODING OF MOVING PICTURES AND AUDIO

ISO/IEC JTC1/SC29/WG11
MPEG97/
July 1997

Source: **EPFL**
Status: **Proposal**
Title: **Proposal of a watermarking technique for hiding/retrieving data in compressed and decompressed video**
Author: **Fred Jordan, Martin Kutter, Touradj Ebrahimi.**

1. Introduction

EPFL is part of the Talisman consortium which aims at developing technologies for copyright protection of video data, as described in “Talisman proposal: protection and automated monitoring of digital objects” document. Two main complementary solutions may be used for copyright protection: labeling and watermarking. This proposal is focusing on watermarking technology.
The watermarking is a technique which hides information by a slight modification of the video data. This modification should be:
- Robust to compression and manipulation
- Invisible
The information itself is a number of bits typically ranging from 16 to 128 which can be used to identify the author (signature), the content, the label....etc.

2. Technique Description

2.1 Principle

We present a technique which enables to sign/retrieve information directly on an MPEG-4 compressed bitstream. The information is hidden by a slight modification of the motion vectors.

- **Signing:**

The signing operation is made by extracting the motion vectors directly from the compressed bitstream.

- **Retrieving signature from Bitstream**:

The signature can be retrieved from the bitstream, exactly as if it was a label.

- **Retrieving signature from Video:**

The signature can also be retrieved after the bitstream has been decompressed. In this case, the MPEG-4 video encoder is applied to reconstruct the bitstream from which the motion vectors are extracted.

2.2 Signing technique

The following rule is used for signing a motion vector component, for instance horizontal component V:

Let b={0,1}, the bit value to embed.

if ((V**q*+T) modulo 2) $\neq$ b
    V' = V + δ
else
    V' = V
and T = 2*<*SearchWindow used for Motion Estimation*>
and δ=*(2n+1)/q, n* integer.

Typically *n*=1 for Null motion vector and *n*=0 otherwise. q is used to specify the amplitude of the motion vector modification (*q*=2 for half pel signing).

V' is the signed version of the original motion vector V.

Block selection:

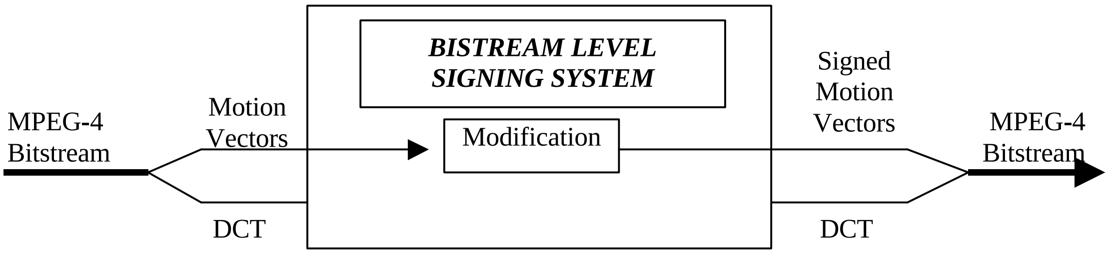
The block is selected using a criteria which can be:

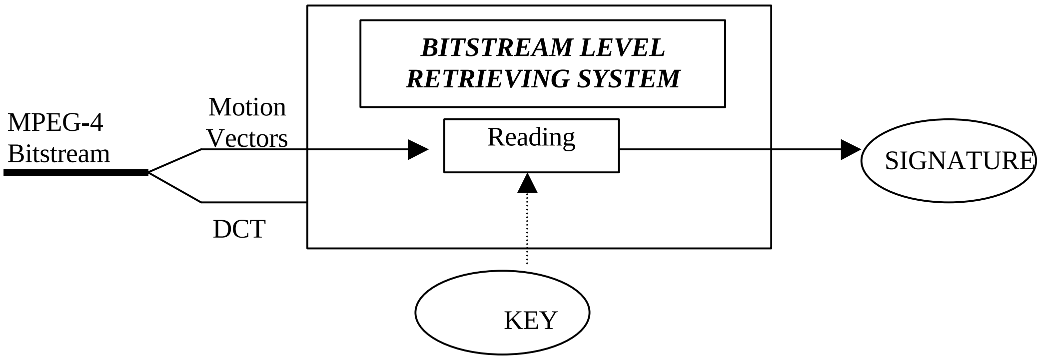
1. Vector Modulus,
2. Random choice initiated by a key,
3. DFD energy,
4. The same located block of the next frame is transmitted in Intra mode,
5. ...

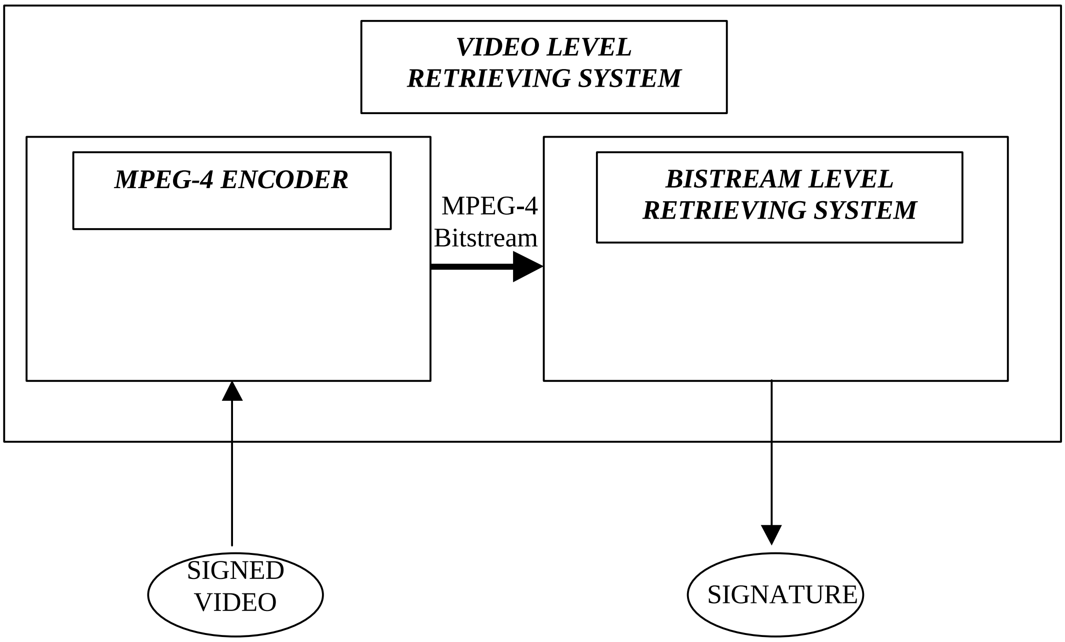
2.3 Retrieving technique

Let's assume we have retrieved a vector V' from a MPEG-4 bitstream.

The rule is:
b = (V'*q+T) modulo 2


BISTREAM LEVEL
SIGNING SYSTEM
MPEG-4
Bitstream
Motion
Vectors
Modification
DCT
Signed
Motion
Vectors
MPEG-4
Bitstream
DCT


BITSTREAM LEVEL
RETRIEVING SYSTEM
MPEG-4
Bitstream
Motion
Vectors
Reading
DCT
SIGNATURE
KEY


VIDEO LEVEL
RETRIEVING SYSTEM
MPEG-4 ENCODER
MPEG-4
Bitstream
BISTREAM LEVEL
RETRIEVING SYSTEM
SIGNED
VIDEO
SIGNATURE

3. Implementation & results

The implementation has been made using the Momusys VM Version 7.

Parameter q:
Several sequences have been signed using either q=1 or q=2.
q=1 is very robust to compression (down to 1Mbit/s in CCIR601, 25 frame/s with quantization inter and intra=30)

Signature:
16 bits and 32 bits signature have been used.

Block Selection:
Random selection of 1 block per frame. Two bits are hidden in each motion vector (horizontal and vertical directions). Advanced predicted block have not been used for signing.

Computational complexity:
The computational complexity is negligible. It has not been possible to identify any significant delay of the Momusys software running with or without this signing technique.

Influence on the Bitrate:
The signing process may generate a very slight increase of motion vector entropy which could in turn generate a very little increase of the bitrate.
For instance 4 bits of difference have been measured between a sequence of 5 frames of coastguard compressed with or without signature. This corresponds to a compressed bitstream of 188700 bits (around 0.002 % of bit rate increase).