Video Quality summary

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Artificial Intelligence &
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Video Quality

- **Video Quality Assessment Methods**
- Subjective Quality Assessment
  - MOS and DMOS
  - Preference factor (PF)
- Objective Quality Assessment Metrics
  - Psychophysical Metrics
  - Engineering Metrics and Methods
  - PEVQ
  - Pixel – based Metrics
  - VMAF
- Camera image quality

Video Quality Assessment – Methods

Video Quality Assessment methods are the same as those used in Image Quality Assessment:

- Subjective Quality Assessment
- Objective Quality Assessment

Video Quality Assessment – Methods

We can see how these methods can be categorized as displayed in Figure 1 [REN2014].

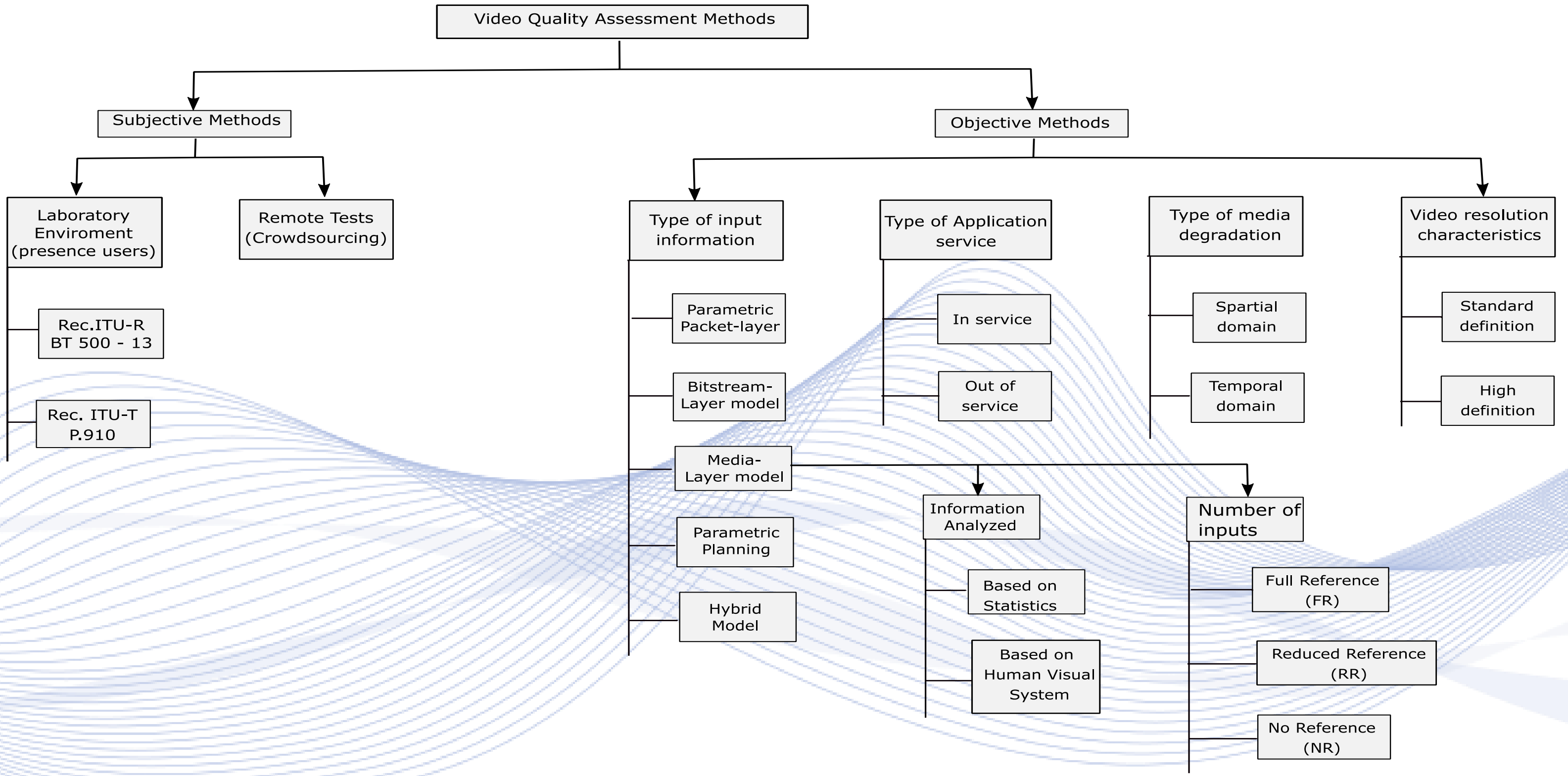

Fig.1 Classification of Video Quality Assessment Methods using different criterions.

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MOS and DMOS

- The outcomes of a subjective experiment are used to compute Mean Opinion Score (MOS) or Differential Mean Opinion Score (DMOS).
- MOS and DMOS are used as input for the development of different objective quality metrics [VQA2014].
- **MOS and DMOS difference** [VQA2014] **:**

  MOS is the outcome when the subject rates a stimulus in isolation.

  DMOS is the outcome when the subject rates the change in quality between two versions of the same stimulus.

Preference factor (PF)

In video streaming service, the user's Quality of Experience (QoE) is related to video signal quality received at consumer's devices and the users' subjectivity. Here, the method in video quality assessment that is going to be analyzed is connected with the preference of a person into a specific video content type. [REN2014]

Preference Factor (PF) has to do with the human subjective opinion and preference and it is a function that works as a correction factor, because it adjusts the MOS index scores obtained by an objective metric, so it can improve the correlation with the real user's QoE. [REN2014]

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Objective Quality Assessment Metrics

- Objective quality metrics:
  - Psychophysical metrics
  - Engineering metrics
- The purpose of objective quality metrics is to automatically predict MOS with high accuracy.

Psychophysical Metrics

- They aim at modeling the HVS using aspects such as contrast and orientation sensitivity, frequency selectivity, spatial and temporal pattern, masking and color perception.
- They can be used for a wide variety of video degradations.
- Demanding computation.

Engineering Metrics

- Simplified metrics based on the extraction and analysis of certain features in a video [VQA2018].
- A set of features or quality – related parameters of a video are pooled together to establish an objective quality method, which can be mapped to predict MOS [VQA2018].

Objective Quality Assessment Metrics

Video quality metrics are categorized in three more sections [ROV2012].

- **Requirements for reference video information** :

Video quality metrics of this section are categorized into three different kinds of metrics according to the amount of reference that someone has. Those metrics are, Full-Reference metrics, No-Reference metrics and Reduced-Reference metrics.

Full reference metrics: the observers has the entire video as a reference and by using the reference and the test video. Some metrics that belong to Full reference metrics are MSE, PSNR and HVS-based metrics.

Objective Quality Assessment Metrics

No reference metrics: the observer analyze only the test video and do not need any information about the reference video. They can be used in a compression and transmission system where the reference video is unavailable.

Reduced reference metrics: Reduced reference metrics extract a number of features from the reference video (e.g. the amount of motion or spatial details) and make a comparison between the reference and the test video based only on those features. They also are a fusion of full reference and no reference metrics.

PEVQ metric

- Perceptual Evaluation of Video Quality
- Psychophysical metric
- Full reference metric
- It uses distortion classification of measures of the perceptual differences in the luminance and chrominance domains between corresponding frame [VQA2018].

Pixel – based Metrics

- The most used engineering metric [VQA2018].
- Peak Signal to Noise Ratio (PSNR): It is the proportion between the maximum signal and the corruption noise [PVQ]
- Video Structural Similarity Index (VSSIM)
  - SSIM values are calculated for all the frames but in the pooling stage the averaging is weighted based on motion between consecutive frames.

VMAF metric

- Video Multi – method Assessment Fusion (VMAF): It was recently proposed by Netflix as a full reference perceptual video quality assessment model that combines quality-aware features to predict perceptual quality. VMAF combines human vision modeling with machine learning, offering a good prediction of the video QoE. The VMAF score was computed using Netflix video streams delivered over TCP (i.e. without packet loss nor bit errors) to adjust compression and scaling parameters that ultimately impact QoE. [PVQ2019]
  - Engineering metric
  - Full reference metric
  - Used in Netflix

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Quality Assessment – Video Camera

The image or video quality can vary between different cameras, even if they have the same horizontal display resolution (2K, 4K etc.).

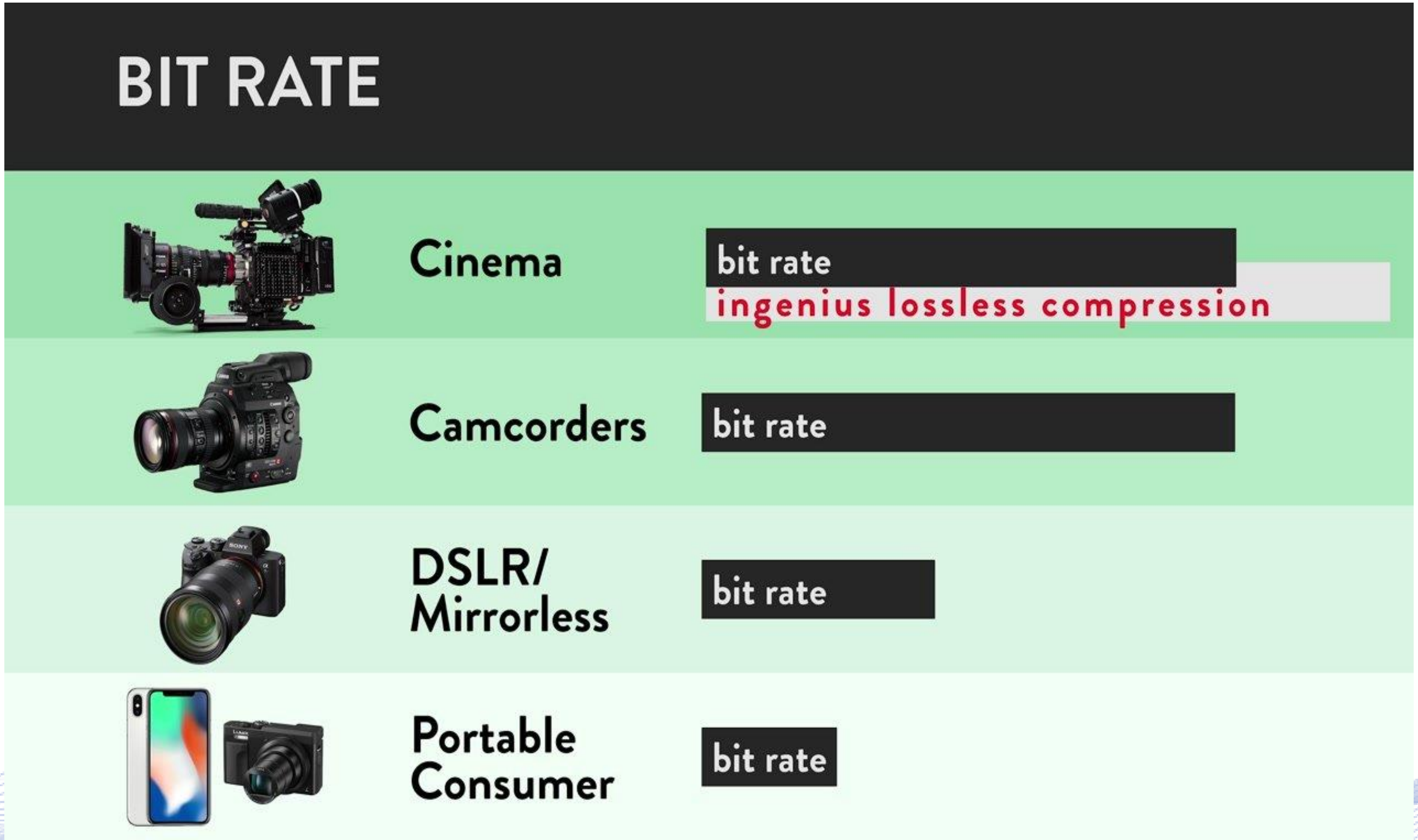
This is due to the main factors of a video camera and the way they affect the quality of the video [SPR2019].

There are three main factors:

- Bit Rate
- Bit Depth
- Chroma Subsampling

Bit Rate

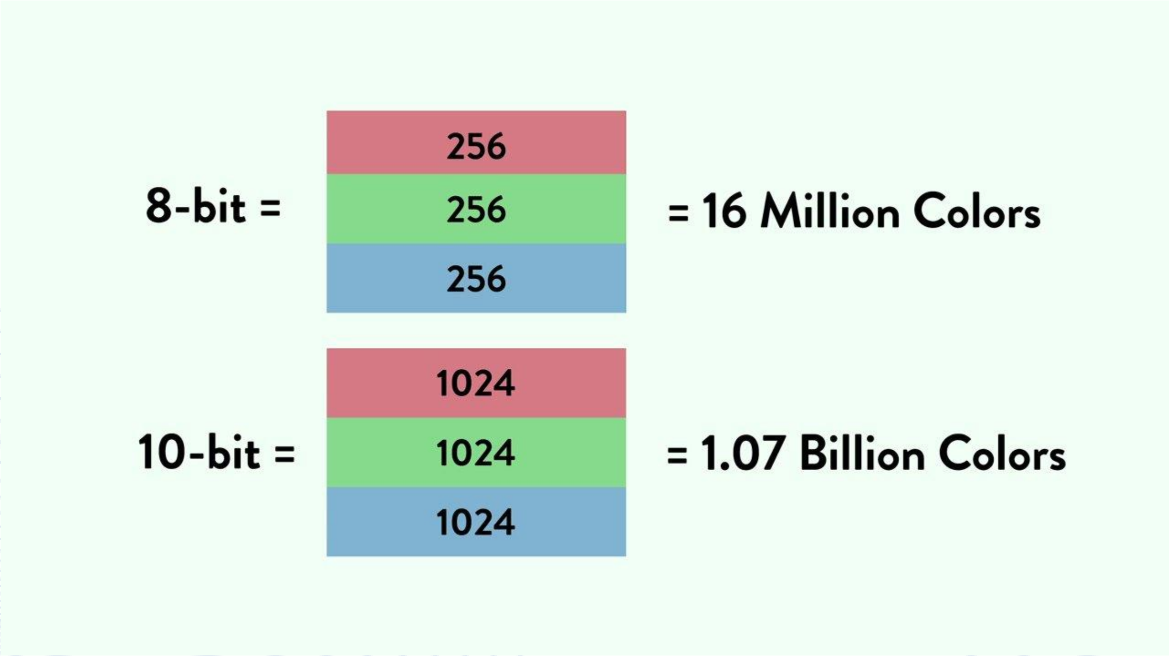
- The amount of data the camera records per second.
- A higher bit rate equates to higher quality footage.
  - It allows the camera to record more details about each frame.
- Once you hit the maximum bit rate the recording media can handle, bit rate levels off as a factor in image quality. Then, image compression becomes more important than bit rate for image quality [SPR2019].



Bit Rate of various devices [SPR2019].

Bit Depth

- The number of colors a camera can read per pixel [SPR].
- Common bit depths: 8-bit and 10-bit.
- The more colors are captured, the more processing power is required.



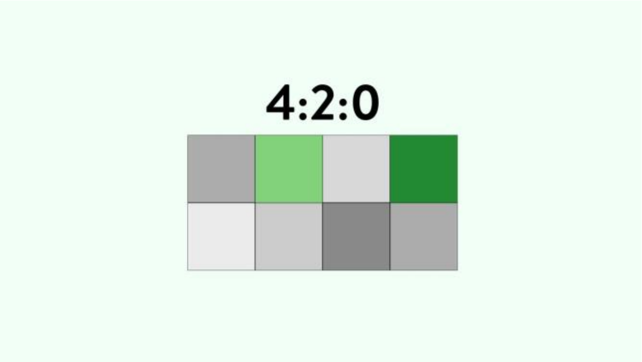
Bit Depth [SPR2019].

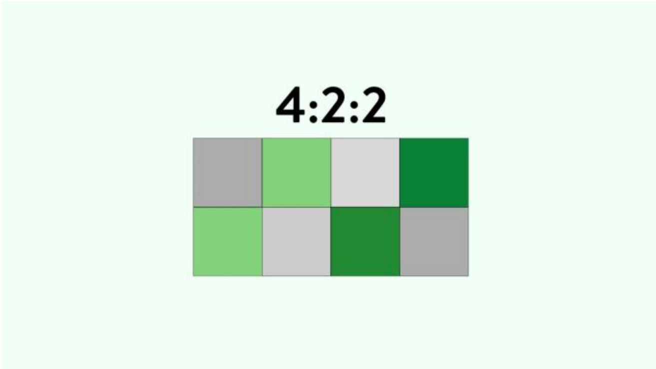
Chroma Subsampling

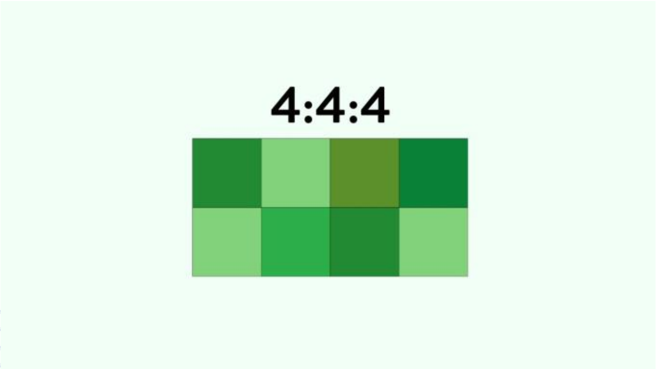
To save processing power, many cameras don't capture color information about every single pixel. Instead, they fill in the gaps by "guessing" what's in between [SPR2019].

- 4:2:0 chroma subsampling: For the first row of four pixels, the camera will capture information from two of them. For the second row, it won't capture any.
- 4:2:2 chroma subsampling: The camera will capture color information from two pixels in each row of four.
- 4:4:4 chroma subsampling: The camera will capture information from every single pixel.

Chroma Subsampling







Chroma Subsampling [SPR2019].

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Q & A

Thank you very much for your attention!

More material in
http://icarus.csd.auth.gr/cvml-web-lecture-series/

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