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# DIGITAL COMPRESSION FOR TELEVISION PICTURES

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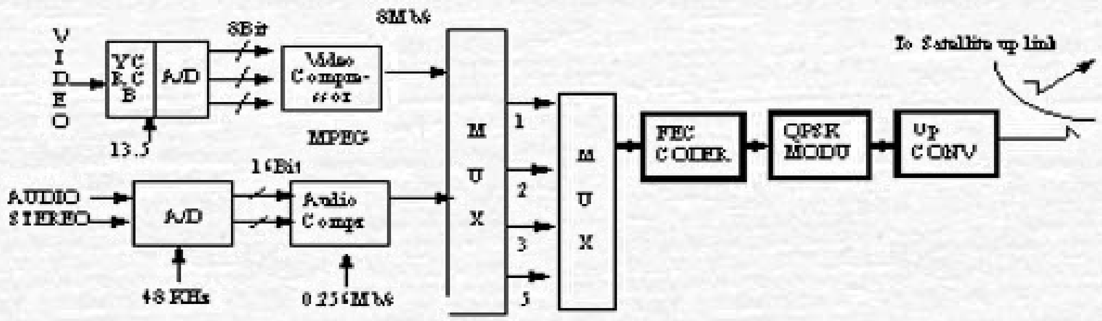
The word "compression" has become very fascinating now days and is being linked with digital technology in general. The advent of digital technology and incorporation of its enhanced capabilities into field of TV technology made the "compression" quite mysterious. It is not only digital domain where recently the compression techniques have started being applied. It is applicable to analog domain also. For our reference we would focus only upon the field of Television technology and would consider the applicability of compression techniques in analog domain as well as in digital.

## ANALOG COMPRESSION:

Compression has a long association with television. Interlace scanning is a simple form of compression applied in analog domain. Here it provides 2:1 compression ratio i.e. reduction in video bandwidth by a factor of two. This was the only attempt at bandwidth reduction in monochrome analog television. It was argued that the main job of interlace was to reduce the horizontal scanning frequency, making the camera and display equipment easier to build, and to reduce the visibility of the raster. Unfortunately interlace exacts a heavy toll on picture quality, resulting in a variety of irrecoverable artifacts.

On the introduction of colour techniques, it was desired that incorporation of colour signal into monochrome should maintain the compatibility criteria in all the three standards i.e. PAL, NTSC & SECAM. There by incorporation of additional colour information signal within the predefined video signal, is one more step towards the analog compression. The use of colour difference signal instead of basic primary colour Red, Green & Blue, is in fact a form of compression. Because as per the psycho-visual characteristics, the human eye is less sensitive to colour details and hence the colour signal needs less bandwidth. Generation of colour difference signal (R-Y) & (B-Y) and transmitting it along with monochrome signal instead of three different colour signals is another form of compression. This compression introduces another form of colour artifacts in reproduced picture.

## NECESSITY OF DIGITAL COMPRESSION:




The technology of the day was restricted relatively to simple processes, and competition for spectrum usage was not serious. Inevitably, analog television standards put simplicity first and economy of bandwidth second. There was thought to be no alternative but to employ the same waveform in camera, broadcast and receiver, with the result that horizontal and vertical blanking intervals, carrying no information at all, were still transmitted.

Many days ago, when today's analog television systems were being designed, conditions were different. Today the pressure for electromagnetic spectrum use is greater than it has ever been, and the parts of the spectrum reserved for conventional analog TV have become increasing valuable. Since than, the demand for devices, which use radio communication, has increased dramatically. The most obvious of these is the cellular phone and others from security systems to radio-controlled toys, non-of that existed when analog TV was designed.

The decision to adopt digital techniques for television broadcasting has largely been made on behalf of the broadcasters by spectrum allocators seeking to free up valuable spectrum. These agencies don't care weather the technology is digital or non-digital, provided that it uses a lot less spectrum than is currently the case. More significantly, it is not being cared what quality is going to be achieved. In a sense, television broadcasting is being re-housed so that its cottage can be torn down to build an office block. Even if digital television is not more economical than analog and the quality are under trial, lots of money will be made by other industries from the vacated spectrum.

**DIGITAL COMPRESSION:**

Digital television broadcasting has to happen, because service providers can no longer afford the limitations of traditional analog transmission. The broadcaster has to find a more spectrum efficient technology. One of the fundamentals of efficient use of spectrum is compression; digital compression is a way of expressing digital audio & video by using less data. Compression theory suggests that the more effective the reduction in bandwidth has to be, the more complex signal processing at lower cost than for broadcasting using the analog techniques.

Digital technology is extremely powerful in the delivery application. Digital delivery channel are designed to replicate the original bit patterns at the end of a channel exists, error connection can be employed to rectify any bits which are corrupted. Consequently a digital delivery channel working within its specification has no quality at all. It simply transfers the inherent quality of the input signal to another place for the given specifications.

One initial success of digital video was in post-production applications, where the high cost of digital video was offset by its limitless layering and effect capabilities. However, production standard digital video generates over 200 megabits per second of data and this bit rate requires extensive capacity and wide bandwidth for transmission. To fulfill the spectrum efficient technology requirements, digital video could be used if the bandwidth requirements could be eased; easing these requirements is the purpose of compression. The active region of a digital television frame, sampled according to CCIR recommendation 601, is 702 pixel by 576 lines for a frame rate of 25 Hz using 8 bit for luminance & chrominance component the uncompressed bit rates become In 4:2:2 720x576x25x8+360 x576x25x8 (8+8) = 166 Mbit/s

Using the various compression techniques these can be bring down to 3-15 Mbit/s. For digital broadcasting of standard definition video, a bit rate of around 6 Mbit/s is thought to be good compromise between picture quality and transmission bandwidth efficiency. At the lower bit rates in this range, the impairments introduced by coding and decoding process become increasingly objectionable.

**THE MPEG THEME:**

In all real program material, there are two types of component of the signal those, which are novel and unpredictable, and those, which can be anticipated. The novel component is called the entropy and is the true information in the signal. The remainder is called redundancy because it is not essential. Redundancy may be spatial, as it is in large plain areas of picture where adjacent pixels have almost the same value. Redundancy can also be temporal, as it is where similarities between successive pictures are used. A bit rate reduction system operates by removing redundant information from the signal at the coder prior to transmission and re-insertion of it at the decoder in the receiver.

Another kind of redundancy is "Psychovisual redundancy" which is human eye dependent redundancy. According to it the human eye has a limited response to fine spatial detail and is less sensitive to detail near object edges or around shot-changes. Bit rate reduction done on this phenomenon is done is such a way that on decoding, controlled impairment should not be visible to human observer.

All compression systems work by separating the entropy from the redundancy in the encoder. Only the entropy is transmitted and the decoder computes the redundancy from the received signal. An ideal encoder would extract all the entropy and only this will be transmitted to the decoder. An ideal decoder would then reproduce the original signal. In practice, this ideal cannot be reached. An ideal coder would be complex and cause a very long delay in order to temporal redundancy. In certain applications some delay is acceptable, but in videoconferencing it is not. In practice, ranges of coders are needed which have a range of processing delays and complexities. Fig 1 shows the formation of the MPEG TV signal.

The power of MPEG (Motion Pictures Experts Group) is that it is not a single compression format, but a range of standardized coding tools that can be combined flexibly to suit a range of applications. The way in which coding has been performed is included in the compressed data so that the decoder can automatically handle whatever the coder decided to do.

MPEG coding is divided into several profiles that have different complexity, and each profile can be implemented at a different level depending on the resolution of the input picture. Currently, the major interest is in the main profile at main level (MP@ML) which provides a resolution of 720 x 576 pixels. There are many different digital video formulas and each has a different bit rate.

For example a high definition system might have six times the bit rate of a standard definition system. Consequently just knowing the bit rate out of the coder is not very useful. What matters is the compression factor, which is the ratio of the input bit rate to the compressed bit rate, for example 2:1, 5:1 and so on. It is difficult to determine a suitable compression factor. If all of the entropy is sent, the quality is good. However, if the compression factor is increased in order to reduce the bit rate, not all of the entropy is sent and the quality falls. The entropy in video signal varies.

A newsreader has much redundancy and is easy to compress, where as a blowing in the wind or a crowded football match has less redundancy. In such cases we may choose between a constant bit rate channel with variable quality or a constant quality channel with variable bit rate.

**INTEGRATED RECEIVER DECODER:**

The basic digital broadcast system complies the A to D conversion of analogue audio and video signal, suitable production processing, MPEG coding Multiplexing and finally generation of transport stream. The broadcast system allow this transport stream to be recreated at the receiver, which is known as IRD (Integrated Receiver Decoder) shown in fig. 2.

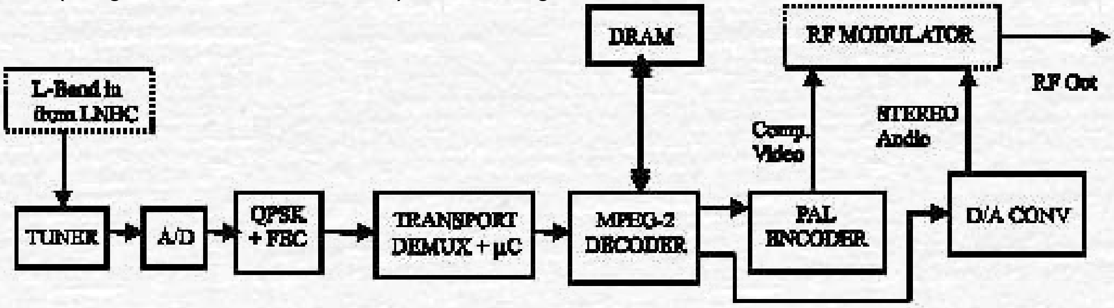



Fig 2 Block Diagram of Integrated Receiver Decoder

An analogue transmitter simply alters the power of the radio carrier in an infinitely variable manner to follow the video waveform. In contrast a digital transmitter can only operate in a discrete number of states. There may be discrete levels, phases or a combination of both. The process, which converts binary data into radio carrier variation, is called a modulation scheme or a channel coding.

Broadcasting is an uncontrolled process, which is subject to noise and interference from unrelated processes, both natural and man made. It is impossible to create an error free link between transmitter and the IRD, so instead error correction is used. Extra check bits are applied to the data at the transmitter, and the receiver uses these to determine which bits were in error so that they can be flipped back to the correction condition.

Typical interference is not contrast, but contains peaks. Away from the peak, the signal can overcome the interference, but during a peak, reception may be impaired for a short time so that a burst of errors occurs. A process called interleaving re-orders the data at the transmitter so that adjacent data bytes are not transmitted sequentially.

The receiver contains an opposing re-ordering system called a de-interleaver, which puts the data back in the right sequence. This process ensures that an error burst is broken up into many small errors, which are then easier to correct. The advantage of digital technique with error correction is that, within region, all of the impairments of analog transmission are rejected. Analog composite broadcast suffers from noise, hue or reflected signals, in addition to the inherent artifacts of composite video. None of these effects are present in a digital domain. However it would be naïve to think that the result would be perfect. In analog system quality goes down in proportion to signal impairment, but the penalty is that the quality crashes with increased impairment.

Error correction system has finite correction ability. Below this limit, the reconstructed data are quite perfect, beyond it they are not. However, the system is able to determine when the limits have been reached. This is just as well, because MPEG compressed data cannot be decoded in the presence of a significant number of errors. In practice the IRD will mute or freeze its output unless the error correction ability. Thus the digital system will simply not work in poor reception conditions. In a given location, if a low enough error rate cannot be achieved, it will be necessary to improve the signal strength or a higher performance receiver.

There are not traditional analog artifacts in a digitally transmitted picture, but the problem is that it involves a higher economics to take place the digital transmission. The digital transmission causes no quality loss what so-ever, but to use it, quality has to lose in the compressor.

**PRESENT STATUS:**

The characteristics of digital television are currently being played down. Digital means no more noise and ghosting and digital means quality, are quite justified facts within the given boundary conditions &

specifications. The comparison should not be made between the analog Vs digital. Every technique has got its merits & demerits.

The important thing is to establish the utilization of the technique employed within the given environment. Advancement of TV in digital era is well justified for the developed countries. Developing countries like India where market is having still enough potential for analog; introduction of digital IRD is an undue financial burden upon the viewer.

Digital compression, undoubtedly provides a substantial saving over the satellite segment, the situation on the ground is quite opposite. Viewer willing to receive the digitally compress channel, compelled to invest substantially large amount for the IRD. There is a danger that the expectation of the public are going to be raised excessively, and that would remain intact is yet to be seen. Because the industry don't have a common standard mean of objective quality measurement or a code of practice for digital IRD till now.

It is still in a pre-mature state without any common platform, which may provide guidelines for service providers to maintain the quality. The digital IRD's available today are not sophisticated enough to protect the user against fraud. Various packages and services are available, each claiming superiority to the other.

Cases of cheating are every where whether in the computers or in automobiles. The risky factor, that no digital service provider promises any form of buy back guarantee in case they decide to cease the transmission due to any unseen reason. In such cases dedicated IRD's lying with viewer becomes a useless piece of electronic equipment. Under these technological upgradation in the present crowded world, one can only wait for things to get stabilize.

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