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Building Principles and Application of Multifunctional Video Information System

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1. Introduction

The beginning of 3 millennium marks evolutionary development of telecommunication and communication branch, including digital TV and broadcasting. It was promoted by introduction of new digital integrated microcircuits, computer engineering, use of new transformation methods, processing, compression and archiving, and also digital methods of great volumes signals modulation.

For today all over the world create a global information infrastructure, a special place in which the multipurpose interactive video information system occupies. And it is not casual - after all over 80 % of the information the person receives through organ of vision.

Basing on the theoretical and experimental research results for last 25 years, structural principles of perspective television system, actually video informational system (VIS) for multipurpose application or multifunctional video informational system (MFVIS) are stated in this chapter. The possibility and expediency of interactive and integrated broadcasting TV system designing necessary for society provision with information on its base is also considered.

2.

Digital TV-broadcasting strengthens an interactivity role. The concept of interactivity accepted by the international organizations, provides complex use of landline, satellite and cable means, harmonious connecting with other telecommunication services, with mobilization of funds for maintenance of reverse channels. The model of digital TV-broadcasting system is presented on Fig. 1.1.

In this system the subscriber equipment forms a local domestic complex basically with cable and other wire connections. Such connections limit opportunities for the equipment location change, its use in an interactive mode. In this connection the complex is supplemented with receive/transmit radio systems of a subscriber providing bidirectional "wireless" access of subscriber devices to direct and return interactive channel. For increase of interest to transition to a digital TV broadcasting a task for transformation of the functions of STB subscriber terminals (multi-purpose interactive devices capable to service broadcasting and many info communication services) limited originally has been applied. Thus, due to multifunctional achieved by software, a cost of such devices practically does not grow. The basic hardware-software means of a receive/transmit path of video

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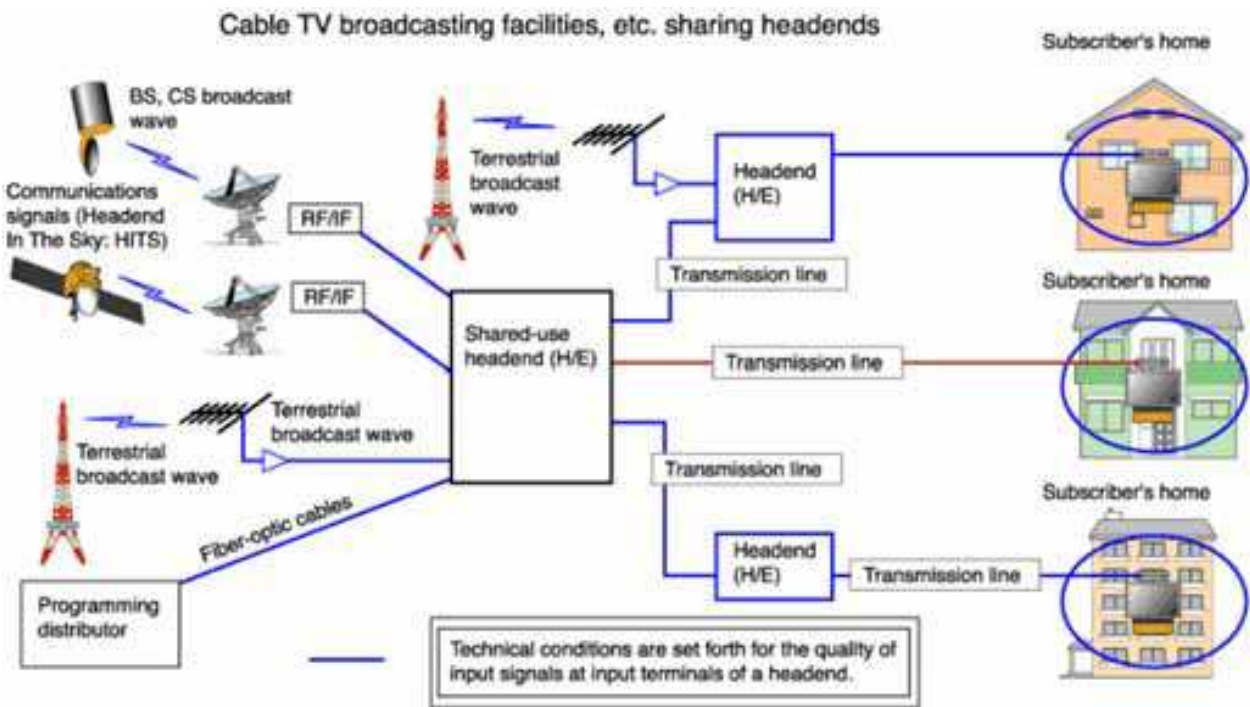


Fig. 1. 1. Global model of digital broadcasting system

information systems offered by author of MFVIS with a universal purpose is a complex of coding and decoding device with adaptively controlled parameters allowing signals compression and decompression of multimedia and packing and unpacking of packets. At the first stage of introduction it is expedient to use analog and digital methods in a combination to technical opportunities and equipment with new digital means of transmission, reception and transmitting environment.

In this case reception on domestic TVs can directly be carried out through a terrestrial network of television broadcasting by means of application of universal multipurpose prefixes for reception both analog and digital TV programs on usual TV made after 1990. Taking into account that a TV image represents huge data file so a speed of a stream about 270 Mbit/s that considerably surpasses opportunities of modern transmission channels is required for their transmission on a TV communication channel with quality of the broadcast standard. Therefore, various methods of coding image and a sound with the purpose of compression of initial volumes of video-audio information due to elimination of their redundancy apply for coordination of parameters of TV program signals and transmission channels.

The main advantages which digital technologies give us are an excellent image and sound, and also increase in number of transmitted channels with expansion of service. For example on a satellite transponder, intended for the normal analog channel, about 8-10 channels of digital television together with a binaural sound are possible to transfer. In result the choice of channels has already visibly grown, and from the satellite now channels can broadcast that could not earlier, at that rent of "place" in 8 times became cheaper. Also, new conveniences which were inaccessible earlier have appeared.

However, needs for transmission of video information still essentially exceed the opportunities, represented for it by TV communication networks, both on availability of communication, and on volume of information which can be transferred through this network.

In this connection now, the problems of development of information space necessary for achievement of economic and political independence are urgent for our republic.

These circumstances urgently demand an increase in effectiveness of operating TV networks, introduction of new broadband digital means and video information systems of communication and also integration of existing local TV networks with the purpose of a single information system creation in the long term in the republic, ensuring an output in to international and other regional communication networks.

The conducted analysis of increases in use efficiency of a throughput capacity of video informational systems (VIS) will allow to reduce essentially a TV signal redundancy that creates a potentiality for increasing use efficiency of a throughput capacity of VIS channel due to transmission on this channel a rather great volume of additional information.

It is known, that resulting transmission speed of a digital stream of TV program signals at component encoding of components of color TV signals with use of normal PCM can be presented as the expression:

$$V_{P0} = V_{\alpha} + 2 V_{\Pi} + V_3 \quad (1)$$

Where:

$V_{\alpha} = n_{\alpha} f_{\alpha}$ is transmission speed of brightness signal - U_y ;

$V_{\Pi} = n_{\Pi} f_{\Pi}$ - transmission speed of color-difference signal U_{b-y} ;

$V_3 = n_3 f_3$ - transmission speed of audio signal;

$n_{\alpha}, n_{\Pi}, n_3, f_{\alpha}, f_{\Pi}, f_3$ - length of codes and a sampling frequency of signals U_y and U_{b-y} (U_{b-y}) accordingly. In non-adaptive digital VIS length of codes, a sampling frequency or resulting speed do not change, i.e. $V_{P0} = \text{const}$.

At organizing of multiprogramming transmission of TV signals on VIS with compression and decompression of its components, resulting speed is defined by the expression:

$$V_{p2}^{-1} = \begin{cases} \Pi(2k-1)m^{-1}(f_{\alpha} + 2f_{\Pi} + f_3), npuk=1, n, \\ \Pi(2k \cdot m^{-1}) \cdot (f_{\alpha} + 2f_{\Pi} + f_3), npuk=2,3, \end{cases} \quad (2)$$

Where:

Π - number of TV programs;

f_{α} - Sampling frequency of brightness signal

f_{Π} - Sampling frequency of color-difference signals

f_3 - Sampling frequency of audio signal

One of directions of TV systems realization allowing to improve a level of information service is transmission of additional data, convergence, texts, including on TV viewers requests. VIS model contains a logic and physical structure which has both a direct and return communication channel.

On the basis of logic and physical structures, and also structures of an information data packet it is possible to make a generalized model of VIS, intended for providing various additional services except basic video information, and also giving an opportunity for computer processing and archiving images with compression on subscribers' requests. (Fig.1.2.)

Now the level of communication equipment of users has considerably increased, and the majority of users are expressing now desires to communicate with an external world. In this

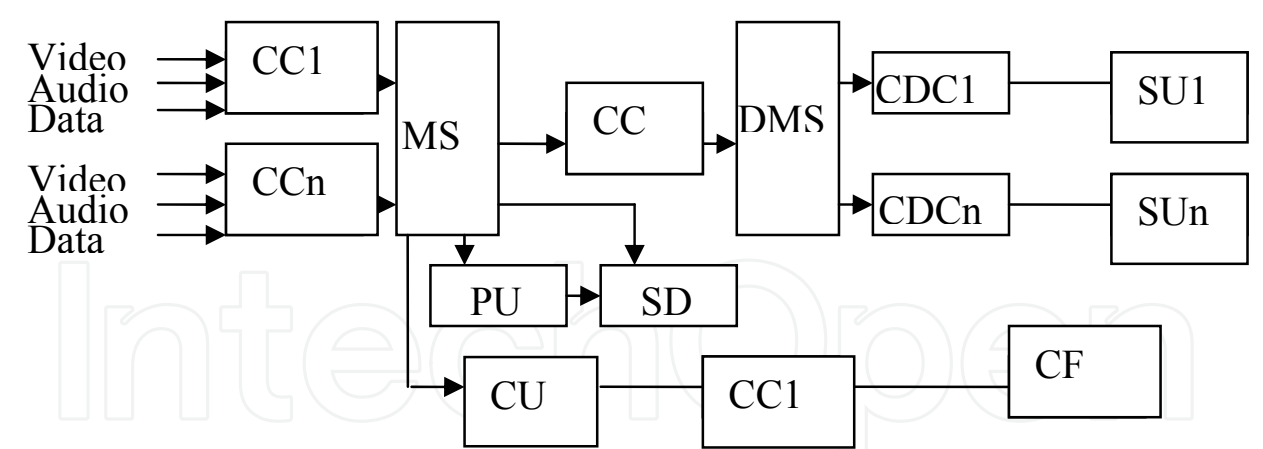


Fig. 1. 2. The generalized circuit model with compressions of a TV programs signal and additional information.

- Where CC1, CCn- complex coder
- MS- multiplexer
- PU-processing unit
- CU- control unit
- CF-call facility
- CDC1, CDCn -complex decoder
- SU- subscriber's unit

connection many foreign firms have started developing technologies simplifying such an exchange with providing to users an opportunity for reception of a single integrated access to information by means of processing universal system [1].

The basic directions of the research are connected with the search of optimum methods of orthogonal (mathematical) transformation on the base of Wavelet and Fourier analysis.

Efficiency of MFVIS in many respects is defined by a method of signals transformation with the purpose of maintenance of high compression ratio at a preservation of the set requirement to the quality of a restored image.

Most frequently the Fourier analysis which represents an original signal as a set of harmonic signals is used for these purposes. It allows to transfer an initial electric signal A (x, y) from time area into spectral area F (w_x,w_y).

In Fig.1.3 the opportunity for the adaptive coder designing based on a combination of methods of adaptive linear prediction (ALP), correlation prediction (CP) is submitted, and is discrete cosine transformation (DCT)

Optimization of VIS parameters with an adaptive linear prediction was made by computer simulation with application of the mathematical device of a difference equation. The final difference equation connecting input signal U_n (k,l) with a target restored signal U_n B(k,l) looks like:

$$U_n\epsilon(k,l)-\sum_{k=1}^n\sum_{l=1}^ma_{k,l}U_b(k-1,l-1)\cdot K_{oc}+\sum_{k=1}^n\sum_{l=1}^ma_{k,l}U_b(k-1,l-1)\frac{K_{oc}}{m_0}=\frac{1}{m_0}U_n(k,l) \tag{3}$$

- a_{k,l} weight ratio of predictors:
- N, M- number of elements participating in a prediction:
- Where d is a size of DCT fragment, U_{k,l} - values of luminance, k,l - points of a fragment, U_{k,l} - sum of luminance values of adjoining points.

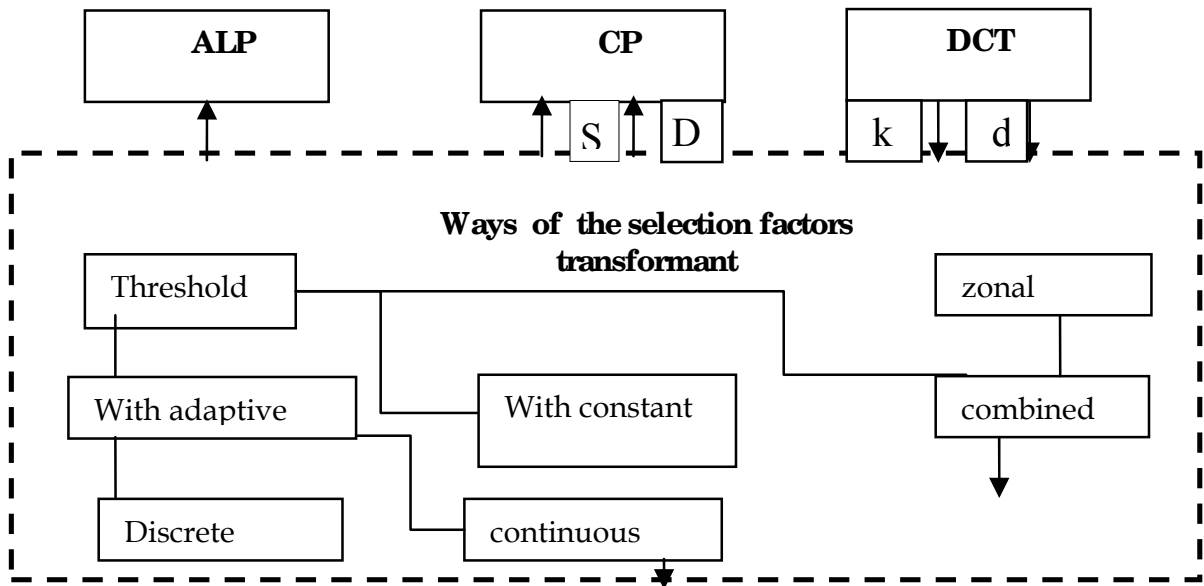


Fig. 1. 3. Structure of construction the compression signals device on the basis of images complex coding method.

The resulting compression factor at simultaneous use of all three coding methods can be written down for adaptive (K_{pca}) and non-adaptive encoders (K_{pc}).

$$K_{pc} = V_1 / V_2 = K_1 \cdot K_2 \cdot K_3, \tag{4}$$

$$K_{pca} = K_1 \cdot K_{2a} \cdot K_3, \tag{5}$$

Where:

$$V_1 = f_{\partial \text{ян}} \cdot n_{\text{ян}} + 2 f_{\partial \text{ун}} \cdot n_{\text{ун}}, \tag{6}$$

$f_{\partial \text{ян}}, f_{\partial \text{ун}}$; $n_{\text{ян}}, n_{\text{ун}}$ - nominal sampling frequencies and codes length of luminance signals and color-difference signals.

$$K_1 = \text{Log}_2 L_n / \text{Log}_2 L_k, \tag{7}$$

Where:

$L_n=2^{n_n}$ -quantizing level of an original signal ($n_n=8$) .

$L_k=2^{n_k}$ -quantizing level of the transformed signal ($n_k=5$)

$$K_2 = \frac{N^2 \cdot \log_2 L_m}{\sum_{U=0}^{N-1} \sum_{V=0}^{N-1} n_{U,V}}; \tag{8}$$

L_m - maximal value of luminance.

$$n_{U,V} = \frac{\sqrt{F^2(u,v)}}{F_n} \text{ -number of elements participating in a prediction}$$

F_n - threshold of restriction.

$$K_3 = 2^I; \quad (9)$$

I -number of recurrences.

$$K_{2a} = \frac{N^2 d \cdot}{\sum_{U=0}^{N-1} \sum_{V=0}^{N-1} \frac{\sqrt{F^2(u,v)}}{dy - \arctg((Q_c - dx)/e)}}; \quad (10)$$

Where:

$$F(u,v) = \sum_{x=1}^N \sum_{n=1}^N L_{BX}(k,l) \cdot W(j,g,u,v); \quad (11)$$

$W(j,g,u,v)$ – nucleus of direct transformation

j,g – number of a line and column in the image's block

u,v – number of a line and column in the spectral factors block

$L_{BX}(k,l)$ – luminance samples of an original signal

dx, dy – center symmetry coordinates of $\arctg$ function

e,d – factors influencing a compression degree

$$Q_c = \frac{1}{(d-2)(dS-2)} \sum_{i=1}^{d=2} \sum_{j=1}^{d=2} (8U_{i,j} - U_{i,j}^*), \text{ - complexity of a fragment}$$

$$K_{23} = \frac{N^2}{\frac{N^2}{S \cdot K_{2a}} + \frac{N}{S}(S-1)16h_0}; \quad (12)$$

S - lines number in transformation block.

h_0 - the normalizing factor, which taking into account a volume of the additional information

The results of a computer simulation have shown that distortions of a restored signal reduces due to block artifacts at VIS variant combining ALP and DCT or CP and DCT methods, alongside with increase of compression ratio by 10-15 %.

3.

The possibility of broadcasting television signal real-time transmission over cellular networks has been studied. The results of experimental investigation of discrete cosine and wavelet based video and audio compression techniques efficiencies have been compared. It was shown that wavelet based compression algorithms allow achieving the necessary compression ratios while conserving sufficient video and audio quality for bandwidth limited cellular networks transmission.

It is known that efficiency of TV program preparing for further broadcasting is directly related with a time required to transfer the filmed material to television center editorial office. However, sometimes lack of a wide bandwidth communication link does not allow performing the data transfer at once. That's why on the news mostly only reporter's voice is broadcasted with a static background instead of a full video. This problem can be solved by using cellular network communication links for effective TV-signal transmission.

Besides cell-phone main functionality, modern cellular communication facilities allow data transfer that permits to transfer multimedia information and access the Internet. Nokia-N92™ cell-phone announced by Nokia® is a first apparatus of the N-family of Nokia with embedded function of DVB-H television programs receiving and recording. TV program view is performed with 2.8 inches (71mm) screen which has resolution of 240x320 pixels of 16 millions colors. This is not enough for quality television image which requires 720x576 pixels resolution.

Cellular communication systems of generations 2.5 and 3 provide data transmission with up to 2 Mbps bandwidth that allows digital TV signal transferring. However, the TV digital data transmission rate should be limited by the value of 2 Mbps while conserving sufficient video and audio quality. Video transmission rate can be significantly reduced by using an appropriate compression scheme. For this purpose the MPEG video coding standard [2] defines three types of frames to be transmitted: intra frames (I-frames), predicted frames (P-frames) and bi-directional interpolated frames (B-frames). I-frames hold an exact input image structure. These are reference frames for decoding starting. P-frames hold the difference between current frame and the previous one (I- or P- frame). Finally, B-frames store only the most significant changes between previous and next frames.

In practice I-frames compression ratio is not very high (up to 30% of initial data size) as far as I-frames are compressed just in order to eliminate the image spatial redundancy. P-frames usually take one third of I-frames data size, while B-frames take only one eighth. So, to achieve maximal video data compression rates I-frames should not be used frequently. For decoder stability it is desirable to transmit every 10th frame as I-frame, that is also required when a subject image changes. The frames order of MPEG-2 data stream is represented in the Fig. 1.4.

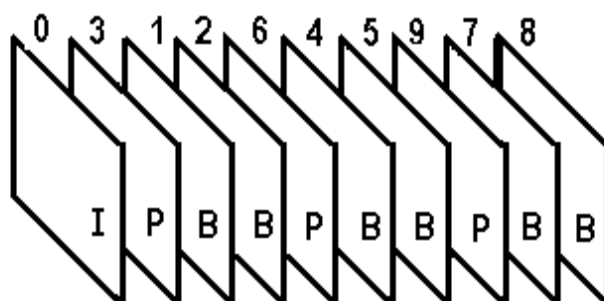


Fig. 1. 4. MPEG-2 frames order

To eliminate image spatial redundancy the most common approach is to use discrete cosine transformation (DCT) [3] proposed by V. Chen in 1981. DCT is used in MPEG-1 and MPEG-2 standards. In general DCT is just a two-dimensional discrete Fourier transformation, but uses only cosines as basic functions. The advantage of DCT usage is its' fast series convergence for most of images. This provides high compression ratios for minimal image reconstruction error.

Image encoding method using DCT is based on frame decomposition by square blocks of 64 pixels (8 by 8) each referred as signal matrices. The idea of this method is to transform the initial image signal matrix to frequency values matrix of the same dimension. The frequency values matrix is not related directly with pixels position of the initial image, but presents a convenient mathematical form for DCT coefficients. In this way frequency matrix can be considered as two-dimensional spectral representation of image fragment. In this matrix the

upper-left corner stands for low-frequency DCT values while the bottom-right is high-frequency ones.

For most of images the significant part of energy is concentrated in low-frequency region. This is very important DCT feature in the sense of data compression. High-frequency coefficients usually take zero or near-zero values and can be discarded, so DCT coefficients with significant values above defined threshold is transmitted. The values lying under the defined threshold are concerned as zero values. Subjectively loss-less video compression is achieved if only zero values of frequency matrices are discarded while data transmission. In such case the reconstructed image will not be distinguished from the original one by a viewer (Fig. 1.11), however the compression ration will not exceed value of 10-20 depending of input image details.

Increase of DCT values threshold leads to increase of image compression ratio as well as loss of reconstructed image quality. So, the rational choose of the threshold value allows balancing between the compression ratio and image quality. Fig. 1.12 illustrates the result of image compression with the ratio value of 45; small details of the images are lost while overall reconstructed image quality is quite acceptable (areas 1 and 2 of the Fig. 1.12).

To achieve a higher compression ratio DCT values quantization can be used by dividing each element of the DCT frequency matrix by quantization values taken from quantization matrix. Each color component (Y, U and V) has its own quantization matrix $q[u,v]$:

$$Y_q[u,v] = \left[\frac{Y[u,v]}{q[u,v]} \right]$$

Other specific features of this compression scheme are also related with quantization. High compression ratios can lead to losses even in low-frequency region, in this case the result image breaks apart to 8 by 8 pixels blocks. As it's shown in Fig. 1.13 quality of image compressed with ratio of 75 become unacceptable (details in region 1 and 2 can't be distinguished).

Thus, considering experimental results of different images compression it is ascertained that TV image compression ratio can not exceed the value of 20-30 while conserving sufficient quality. Theoretically pure video data rate for TV digital signal of resolution of 720x576 can reach the value of 2.5-2.3 Mbps. Indeed, the real video stream including audio and supplementary data transmission rate is much higher, that does not allow using DCT based compression methods for TV signal transmission over narrowband cellular network links.

Besides the DCT based compression techniques, there are alternative video and audio compression algorithms based on wavelet transformation introduced by Grossman and Morlet [3] in the middle eighties.

The main drawback of Fourier transformation (and particularly that of DCT) is an attempt to approximate real non-periodic signals with a help of periodical basic functions. On the contrary wavelet-transformation is based on signal representation by space-limited basic functions of finite energy (wavelets) but in general sense resembles Fourier transformation [4]. However there are a lot of differences between Fourier and wavelet transformations. First of all, wavelets are limited (non-periodic) functions, secondly to obtain a complete transformation basic set maternal wavelet stretching is used, finally basic functions liner composition is replaced by a composition of wavelets temporally shifted and scaled. In general wavelet transformation can be concerned as an act of a certain basic filter, whose impulse response is defined by maternal wavelet. So, a complete wavelet decomposition of

an input signal can be represented as a set of filtering processed followed by operation of decimation (Fig. 1.5).

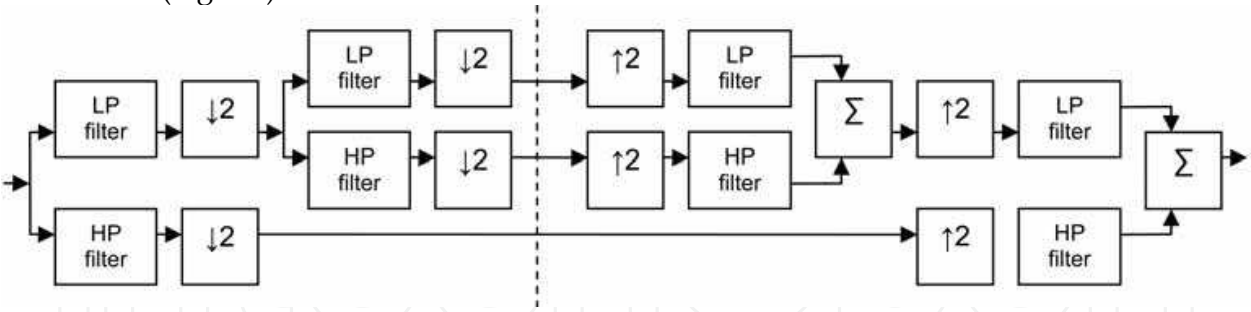


Fig. 1. 5. Generalized block diagram of wavelet decomposition.

Input signal is passed through low-pass (LP) and high-pass (HP) filters, which divide signal spectral band into two parts. That’s why low-frequency and high-frequency input signal spectral bands become two times narrower after the filters passed.

To perform complete wavelet decomposition the input data length should be a power of two: 2^n , where n is a positive integer value. This is explained by the transformation method which divides input signal on two equal parts (low-frequency and high-frequency) at every decomposition step. Another element introduced in wavelet filters is decimation. The decimation operation passes on output every second value taken from input, as far as every second value holds redundant information.

Since an image is a two-dimensional signal, each step of wavelet decomposition is implemented in two stages: at first image rows are treated, then image columns (or vice versa).

Let’s take an image row with a length of N . This row can be represented as an array $S_{[N]}$. Having this the simplest Haar wavelet transformation can be accomplished by meaning of two neighbor pixels colors (low-pass filter) and numerical differentiation (high-pass filter). This gives two array on output $A_{[N/2]}$ and $D_{[N/2]}$ defined as followed:

$$A_k = \frac{S_{2k} + S_{2k+1}}{2}, D_k = \frac{S_{2k} - S_{2k+1}}{2}, \text{ where } k \in [0, N/2).$$

$A_{[N/2]}$ values are referred as signal approximation, $D_{[N/2]}$ values are referred as signal detailing. Obviously, having A and D arrays one can easily reconstruct the initial signal as shown in figure 3, where the numerical values of A and D are represented by pixels brightness.

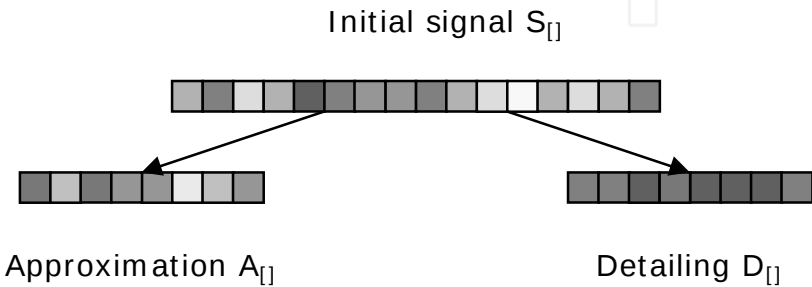


Fig. 1. 6. Single step of wavelet decomposition

Complete image decomposition can be implemented in several steps (Fig. 1.6). First of all image rows decomposition is implemented (Fig. 1.8). After this step passed, the image approximation appears on the left side, while the image detailing – on the right one. A similar treatment is for the image columns (Fig. 1.9). After these two steps, the image approximation appears in the upper-left corner, upper-right corner stands for differential image in the line of X, bottom-left corner is for differential image in the line of Y, and finally, bottom-right corner consists of differential image in the line of X and Y. One can notice that image detailing coefficients take zero or near-zero values (zero values are represented by grey color with a value of 128).



Fig. 1. 7. Initial image

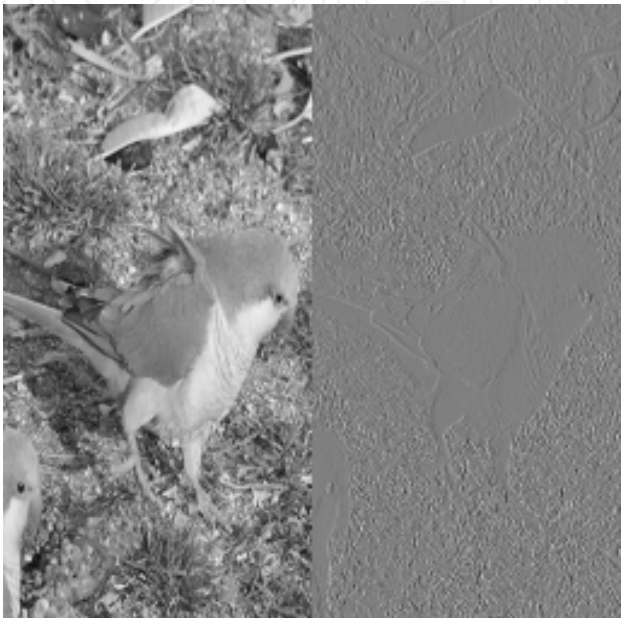


Fig. 1. 8. Rows wavelet decomposition

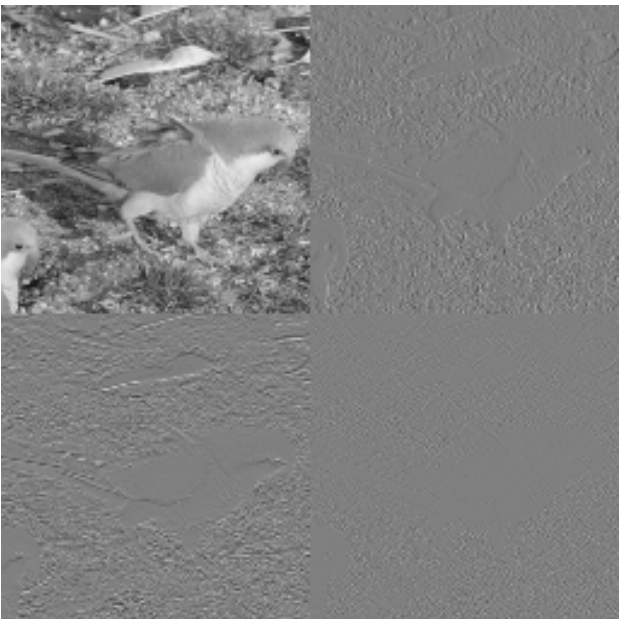


Fig. 1. 9. Columns wavelet decomposition

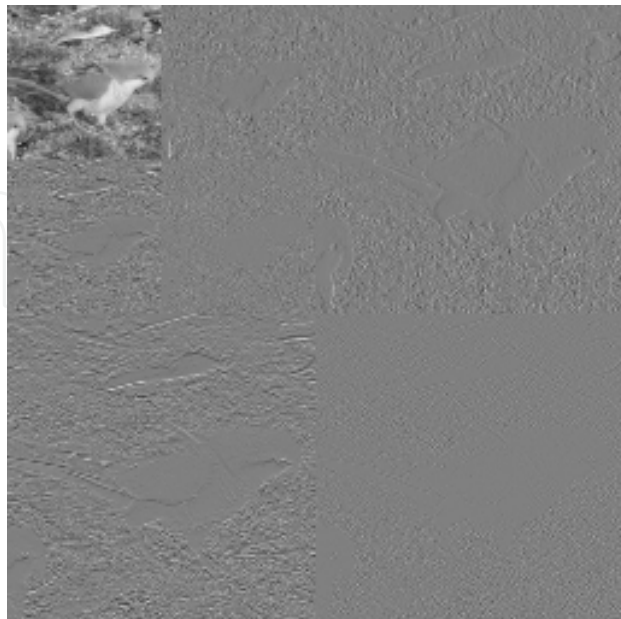


Fig. 1. 10. Two steps decomposition

The further decomposition is performed on the image approximation, which is the initial image two-times reduced copy. The result of the second decomposition step is represented in Fig. 1.10. The decomposition process can be carried out up to the single pixel in the upper-left corner of the image. Obviously, the brightness of this pixel will represent the mean brightness of the whole initial image.



Fig. 1. 11. Initial image used for compression



Fig. 1. 12. Image compressed with MPEG-2 (compression ratio is 45)

Difference between wavelet based image compression and MPEG-2 compression is illustrated in Fig. 1.13 and 1.15. As one can notice, wavelet based compression provides better image quality for the same compression ratio (areas 1 and 2). So, the advantage of wavelets over DCT methods is wavelets' localization within the range of transformation.



Fig. 1. 13. Image compressed with MPEG-2 (compression ratio is 75)



Fig. 1. 14. Wavelet based image compression (compression ratio is 45)

This allows obtaining higher compression ratios for quality image reconstruction. However when the compression ratio is too high, wavelet based compression algorithms can produce ripple artifacts, especially for inhomogeneous regions of the image. Along with image compression wavelets can be efficiently used for audio data compression. In this case coder deals with one-dimensional input data set (or several data sets for multi-

channel audio). Wavelets also introduce some advantages for audio coding and don't yield to MPEG in coding efficiency [5].



Fig. 1. 15. Wavelet based image compression (compression ratio is 75)

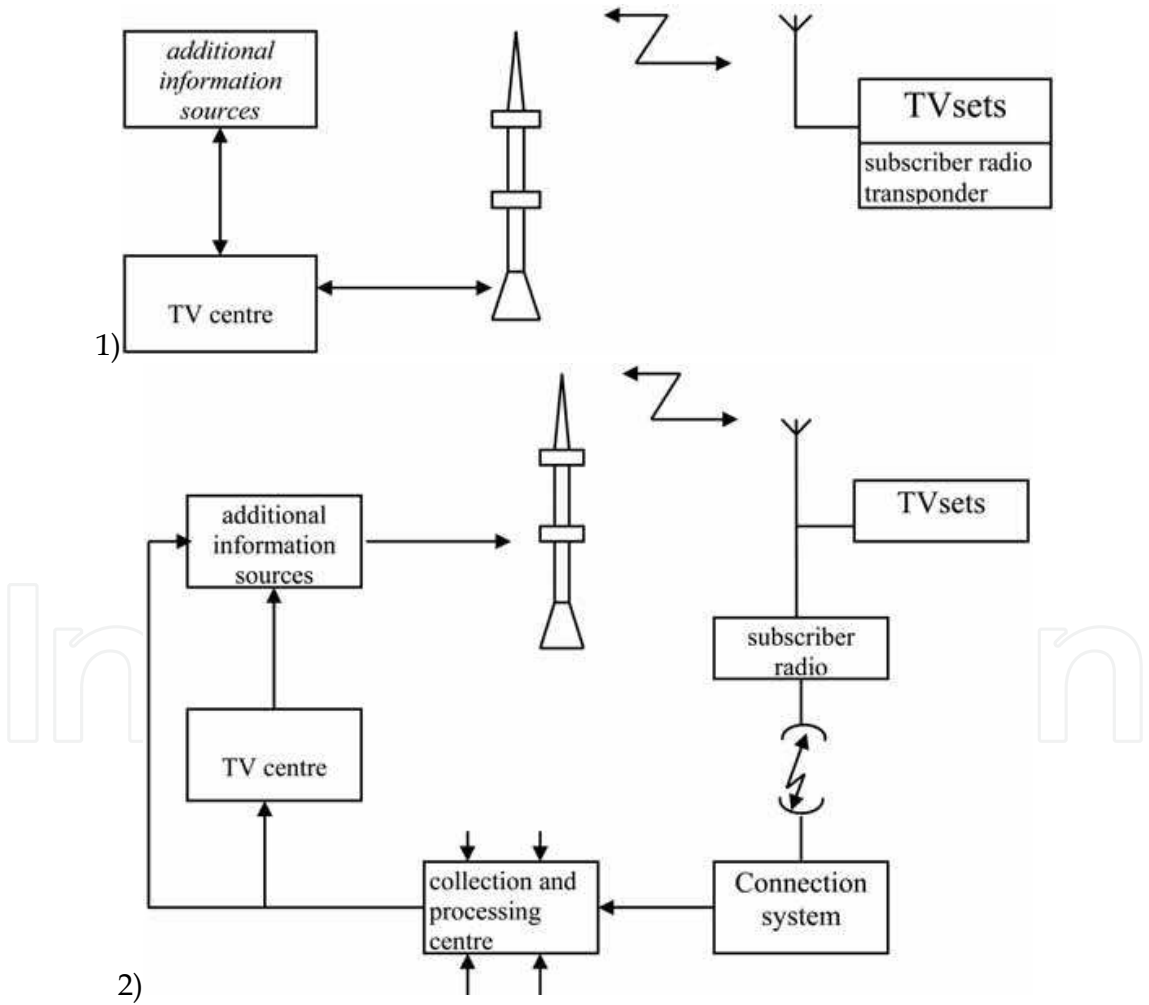


Fig. 1. 16. The organization of interactive digital TV broadcasting system

According to literature data, modern wavelet based coding methods are used effectively in MPEG-4, JPEG-2000 and DejaVu compressors. Analog Devices company produces ADV601

commercial chip which provides real-time video compression using wavelet transformation with up to 350 compression ratio for VHS quality video [6]. Thus, wavelet based compression progress are expected to be sufficient enough to keep video data rate at the level of 1.5-2 Mbps that will give a possibility to use cellular network links to transmit high quality TV directly from the place of event to any spot on the globe served by cellular operator.

4. Multiprogramme stream formed by the broadcasting module and multimedia data formed in the module of multimedia after multiplexing according to global broadcasting TV model are transferred on the monochannel. Which exits are connected to multipurpose user's installations or branch off in other directions using existing environments of transfers for delivery of the corresponding information to remote users. It is important to note combination of existing digital television and broadcasting systems with a view of coverage difficult access region and territories with small number of inhabitants. Thus construction of the reverse channel is necessary. The complex system of tele-radio broadcasting is based on standards DVB-T and DRM. In TV systems and broadcasting with integration telecommunication services takes place, that separate groups or individual users wish to receive the information protected from other users, such VIS systems with the conditional (limited) access are called.

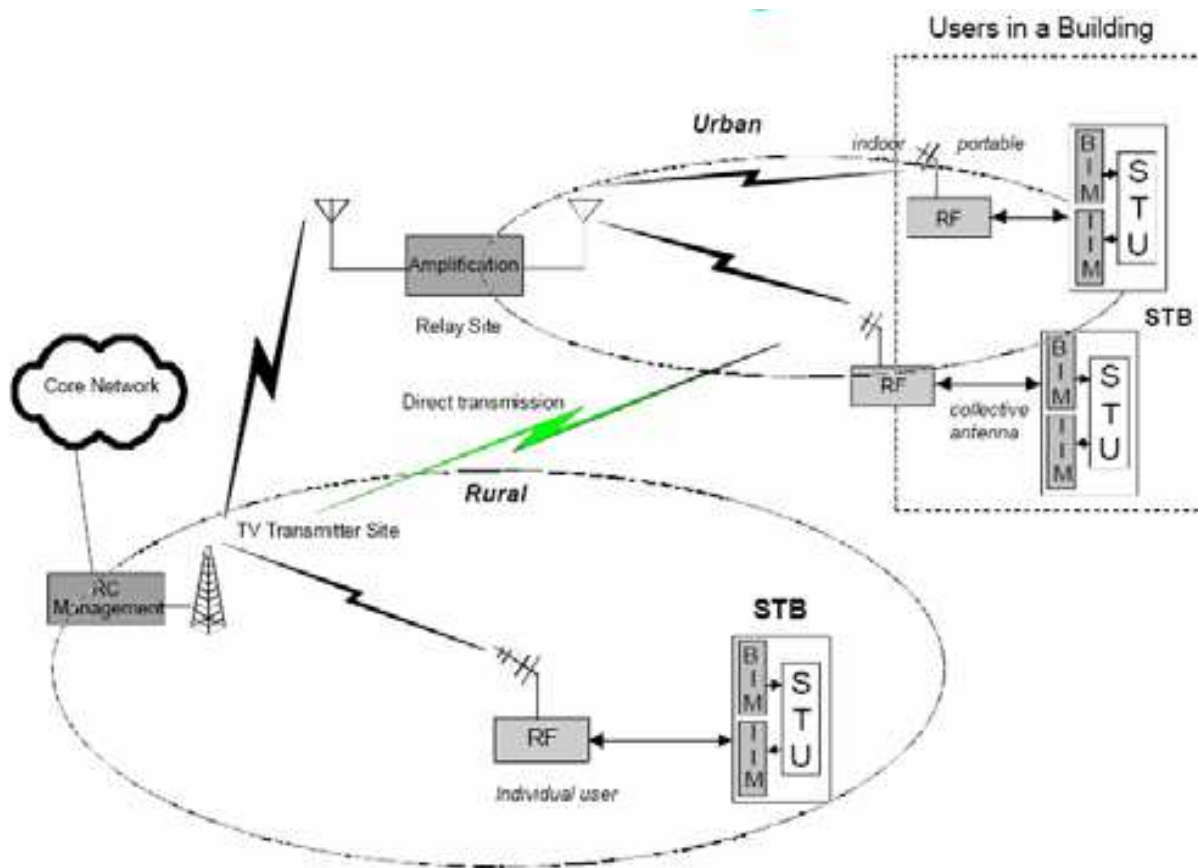


Fig. 1. 17. The block diagrame of Interactive terrestrial digital TV system

In such systems various cryptography algorithms are used: symmetric and asymmetric. Some examples of popular and well-respected symmetric algorithms include Twofish, Serpent, AES (Rijndael), Blowfish, CAST5, RC4, TDES, and IDEA. The most popular asymmetric algorithms is RSA. Generalisation of Cocks' scheme was independently invented in 1977 by Rivest, Shamir and Adleman, all then at MIT. The latter authors published their work in 1978, and the algorithm appropriately came to be known as RSA.

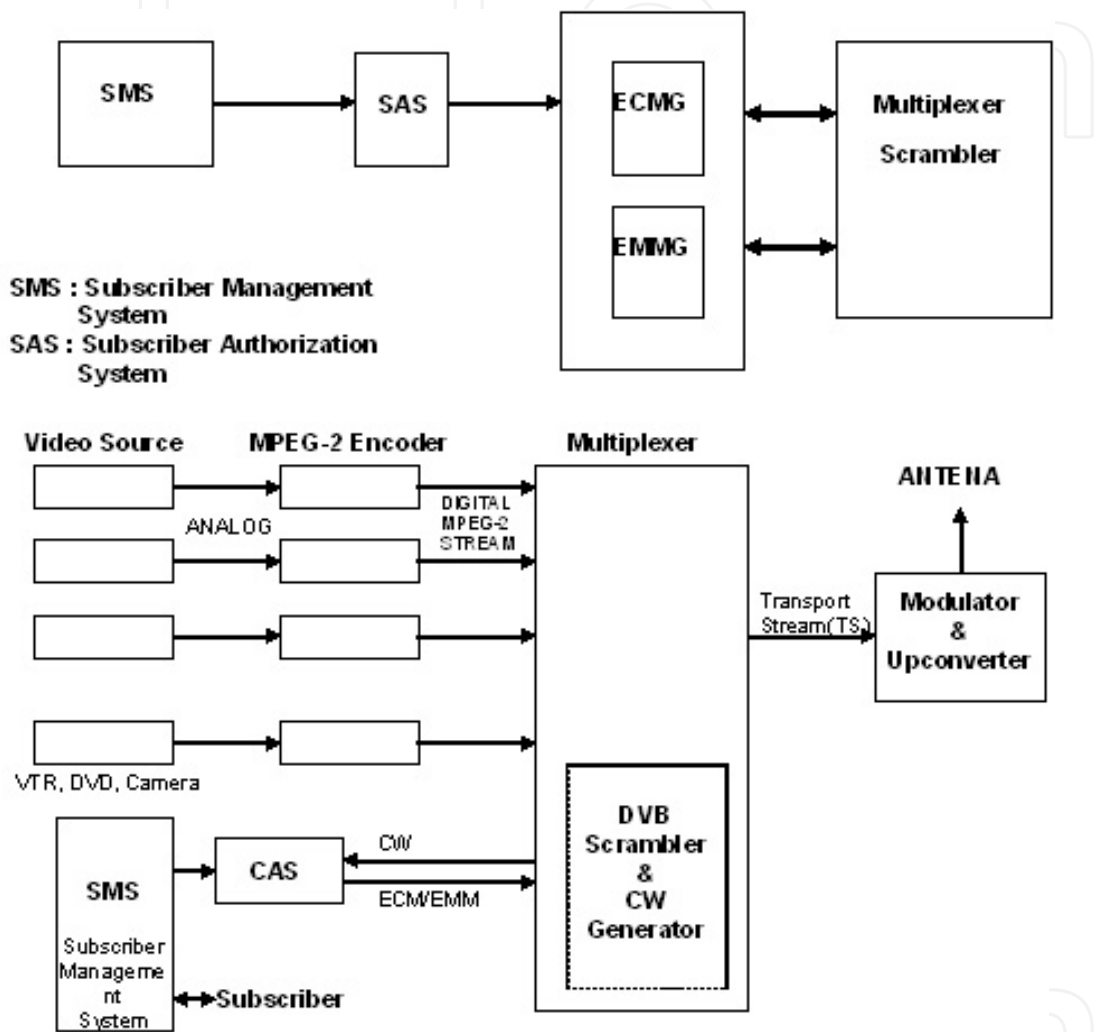


Fig. 1. 18. *The block diagramme of conventional access system*
EIS (Event Information Scheduler)(option)
EMMG (EMM Generator)
ECMG (ECM Generator)

5.

Nowadays for observation of artificial celestial bodies (ACB) broad application as received by photo-television methods, which allows to essentially increase penetrating ability of a telescope, to intensify a visible brightness of stars and object, to increase their contrast concerning a hum noise of the sky [7,8].

On the basis of use of photo-television methods the following principles are fixed:

- Photography of a sidereal field with located observable object (LOO) from the monitor of the video-control device (VCD);
- Visual observation of a sidereal field and object on the monitor of VCD with simultaneous processing on PC, counting of brightness and coordinates immediately on scales of the control panel.

Advantage of the second principle is the high efficiency of obtaining the image with an evaluation of quality and possibilities of reaching the necessary accuracy of installation of brightness and coordinates of the images at the expense of their direct counting (without operations of photography, chemical processing of photos and writing them in the PC for the consequent digital processing).

The creation of a television telescope, i.e. system of optic-television equipment and telescope has opened more capabilities of automation of astronomical observations with use of the PC. It allows not only fast and precisely to determine brightness and coordinates of satellites in relation to rather reference stars, but also expands functionality of TV complexes. In the present time there is a plenty such TV complexes intended for observation ACB.[7-10]

Most important for modern TVIMS is the capability of adaptation of their parameters depending on change of an astroclimate or other factors both fulfillment of diverse functions and problems. In developed and researched TVMIS the multifunctionality is provided at their designing and technological fulfillment. In particular, are used in transmitting cameras CCD matrix actually being multifunctional devices, working on various algorithms depending on pilot signals, modern PC for processing of videosegment and control, and also multifunctional RAM of volume in some television frames (1-4 Mb). This RAM can execute buffering of the videoinformation, in case of low-frame-rate mode- slow record of chosen fragments of a series of frames and slow rewriting in the RAM of the PC.

The increase of MITVS speed is possible by actuation of the external RAM in address space of the PC. Besides, the multifunctional RAM provides visualization both received, and video information, processed in PC. In case of removal of a chamber part on rather large distance, the transmission of the video information and control commands is expedient for executing on FOLC. [9]

Similar MITVS executed on the basis of a television telescope and the PC can decide many problems faster and more effective than person. At observation of AO the received signals of the image are not so great and difference of signals from each other is possible to distinguish with the help of simple tags, i.e. the images of interesting us AO differ in the main size and appropriate amplitude of a signal. [10] Therefore, most perspective is the using for this purpose the television information measuring system (TVIMS), in which are combined hardware and software ensuring automation of process of observation of the objects [11].

The analysis of known, selection and implementation of the substantiation of a structure of construction IMTV has allowed developing structures MFDMITVS distinguished from existing;

- Capability of rigid binding to the beginning of selected frame and maintenance synchronization at the closed and open-ended version of its activity [11,12]
- High effective using of chips of dynamic memory of the RAM [11];
- Maintenance of a reasonable combination manual (through the operator) and program (Through PC) modes and parameters management [9];
- Maintenance of effective coding of the digital video information with the purpose to decrease the time for storage and processing on PC [11-13];

Capability of interface with PC of a type Pentium-133 and control of exchange by the videodata;

Capability of maintenance by a feed from one independent (autonomous) stabilized source;
On Fig.1.19 the block diagram of researched MFDMITVS is shown which contains the following devices and units:

- Television camera on Charge Coupled Device matrix -1;
- Unit of processing of videosegment -2;
- Amplifier with an adjustable transmission factor -3;
- Unit of suppression television synchrony signals -4;
- Unit of binding to reference voltage -5;
- Source of reference voltage -6;
- Analog-to-digital converter -7;
- Unit of packing of figures of videosegment -8;
- Storage device for a record and storage of figures odd half-frame of videosegment -9;
- Storage device for a record and storage of figures even half-frame of videosegment -10;
- Unit of formation of current date and time codes -11;
- Unit of input and adjusting of current date and time -12;
- Shaper of the sign information -13;
- Unit of allocation lower case and personnel synchrony signals -14;
- Lock-in generator of television synchrony signals -15;
- Unit of unpacking of digital data -16;
- Basic digital-to-analog converter -17;
- Personal computer -18;
- Unit of transceivers -19;
- Operation decoder -20;
- Register of output data -21;
- Buffer register of input data -22;
- Register of management and condition -23;
- Unit of clocking and gating pulses -24;
- Counter of addresses -25;
- Multiplexer of the address -26;
- Unit of formation of pilot signals -27;
- Decoder of groups of state elements in 3Y1 AND 3Y2-28;
- Unit of reading of figures and videosegment -29;
- Monitor -30;
- Videorecorder -31;
- Generator of clock television signals -32;
- Monitoring digital-to-analog converter -33;

MFDMITVS functions as follows. Videosegment from the television camera acts on 2, in which the preliminary analogue processing is made with the purpose of suppression of pulse interference and increase of visibility of the transmitted images. [14]

From an output 2 full TV signal through 3 and 4 acts in 5. The unit 3 is intended for obtaining an optimum level of videosegment ensuring an effective digital conversion. The amplified videosegment 3 simultaneously acts on an input 7 through the unit of binding the recovery of a constant making of videosegment and in the unit of allocation of personnel and

line signal clock pulses 14 is made. In 14 the allocation of a signal 64 harmonics of line signal clock pulses. Marked lower case and personnel clock pulses from an output 14 implements act in 15 and provide necessary phasing phased synchronix, and the signal of 64 harmonics acts in 24. In 24 with the help of generator with impulse phase selftuning of frequency (IFSTF) [12] the consequent multiplying of frequency 64 harmonics of a line signal clock pulses up to 24 MHz implements. The generator IFSTF is used by activity 15 in a driven mode. By activity 15 in the independent mode, which can be used at review of the images stored in memory 18, the signals of reference frequency are formed with the help of generator stabilized by a quartz resonator. The selected personnel pulse from an output of 14 acts in 15 and provides necessary phasing of formed signals of synchronix: the generator of synchronix is executed by the classical scheme. From an output of 15 the signal of synchronix acts 17 or 33, where the full videosignal is formed.

The synchronization of activity of MFDMITVS units is provided with the unit of clock and gating pulses located in a module of the control unit. Unit 24 forms clock frequency of synchronization of videosignal 12 MHz, and also group diverse on a phase clock pulses by frequency 3 MHz.

MFDMITVS can function in three operational modes: Automated mode; with control from the PC; Usual TV mode or low-frame-rateTV mode.

From an output of 7 the digital videosignal through the unit of packing of figures of videosignal 8 acts in units 9 and 10. The unit of packing provides a record in rather slowly functioning elements of memory of units of the RAM (9 or 10) figures of videosignal acting with frequency 12 MHz. In the unit 9 the digital data of the first half-frame, and in the unit 10 digital data of the second half-frame are recorded. The sign generator is intended to form digital-letter information and provides data display in a window formed on a field of a plot frame. . The digital-letter data contain the information about current date and time, number of frame. The initial entry about date and time data is made with the help of unit of input and adjusting of current value 11. The unit of unpacking provides issue of digital data on 7 in rate of adopted sampling rate of videosignal at rather slow reading of the data from the RAM (9 or 10). The principle of activity of the unit of unpacking, sign generator and unit of input does not require the special explanations. The address multiplexer of the 26 is intended for byte input of digital datas of videosignal written in the RAM (9 or 10), in 18 with the purpose of digital processing. The decoder of groups of state elements 28 is intended for selection of group of elements of the RAM (9 or 10), by which it is necessary to address at a record or reading of videosignal in 18.

The reading of digital data from units of the RAM (9 or 10) in 18 with the purpose of conversion and return filing of the treated digital information in the RAM (9 or 10) for a visual evaluation of the image on 30 implements through the unit of interface (interface unit), in which structure enter the unit of transceivers 19, operation decoder 20, register of output data 21, buffer register of input data, both register of control and condition 23.

The interface of digital conversion equipment with 18 implements the special interface unit (MOUSTACHE) 29 and for change of rate of input and format of the observable image the standard videoblaster of domestic production of a type SE-100 is applied.

In developed transmitting TV camera on CCD matrix the capability of automatic adjustment of sensitivity by means of the electron obturator is stipulated. The mode of the obturator is selected with the help of switch with constant exposure 1.120 and 40 mlsec. (usual mode)

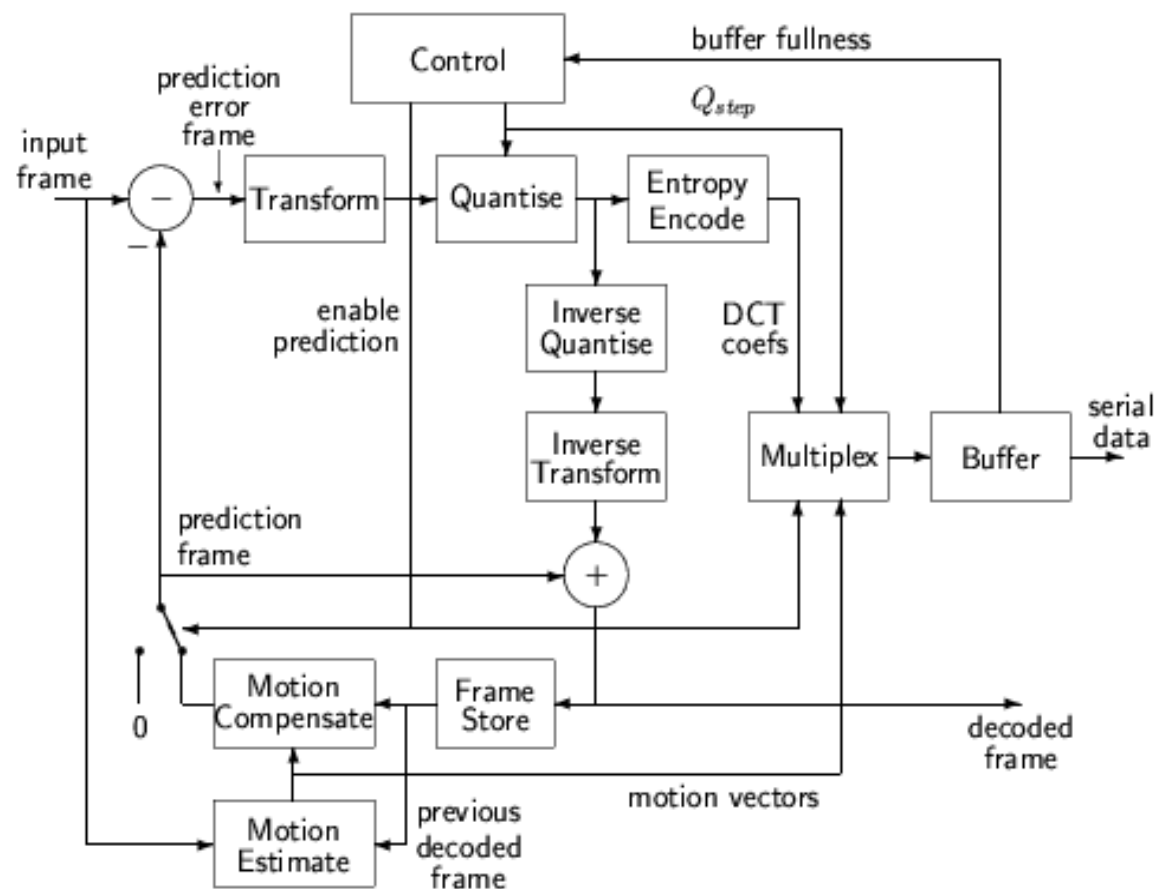


Fig. 1.19. The functional block diagramme of the video coder

6.

Now, for compression of video, there are some various standards to which standards of family MPEG (MPEG-2, MPEG-4), MJPEG, based on discrete-cosine transformation of block structure of images with motion compensation, and JPEG-2000, using wavelet transformations, concern. Thus each standard has the merits and demerits. So, format MPEG-2, using 3 types of the frame, owing to the mechanism of motion compensation of the adjacent frames, allows to get the better general compression of a digital stream, than separately taken keyframes, is provided with comprehensible quality of images at speeds of a digital stream more than 4-5 Mbit/s [15]. However, at smaller speeds of a stream, smoothness change of brightness on borders of blocks is broken, that leads to occurrence of distortions in the form of block effect, reducing legibility and quality of the restored image, as shown in Fig.1.20. In standards MPEG for reduction of digital stream speed the basic compression of video information is carried out due to elimination of interframe redundancy. Usually, it is reached by means of motion compensation methods, thus the information on changes of images in video stream is transferred only. There are very many various motion compensation methods, but in basic their principle of work consists, that original frame is broken on macroblocks for which the maximal conformity in the following frame (Fig.1.21) is searched [16]. If conformity is reached, macroblock is not transferred, since it already exists. If such conformity is not found, the opportunity of such conformity in some area of prospective displacement of

macroblock (to the left, to the right, upwards, downwards) is checked. At detection such macroblock in other position, value of its new coordinates (motion vector) is transferred the decoder. In case of not found conformity it will be transferred the block completely. It allows to receive videostream compression rates much more rather than separately compressed keyframes. However, distortions in the form of block structure of images are inherent in all standards of family MPEG.



Fig. 1. 20. The original image and display of block structure at compression ratio Cr=100 with JPEG.

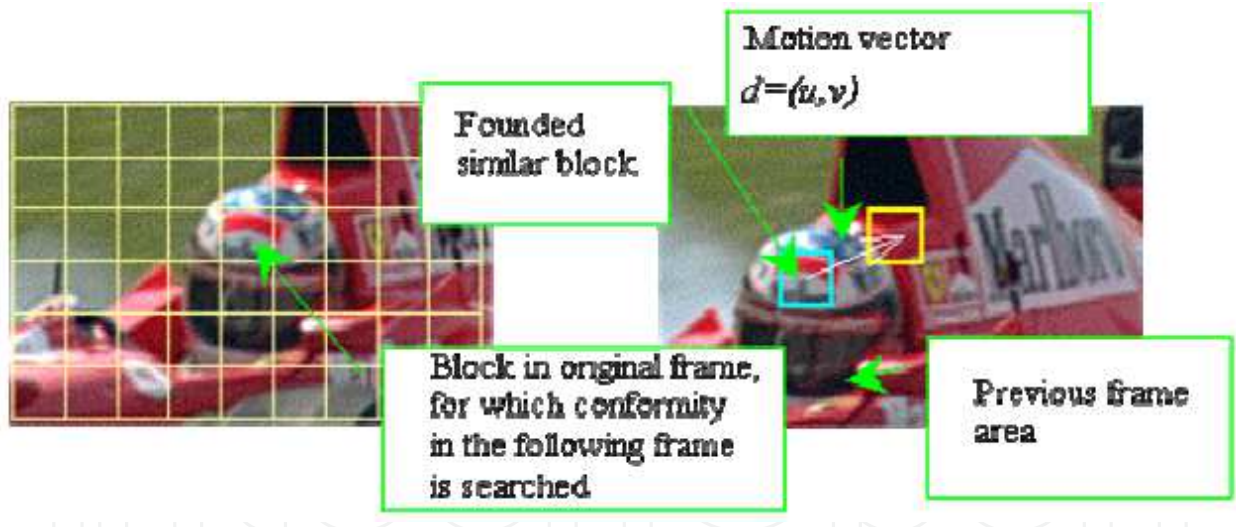


Fig. 1. 21. Principle of motion compensation on the basis of macroblocks searching.

Now rough rates alternative methods of images compression on the basis of wavelet-transformations, at which the image isn't splitted into blocks, and it is processed entirely, develop. It eliminates occurrence of distortions in the form of block effect, therefore images at greater compression rates don't break up to blocks, and simply lose clearness due to border blurriness, but as a whole quality turns out considerably above, than in JPEG (Fig.1.22), that allows to increase compression rate in 1,5-2 times without essentialdeterioration of the image. However, for wavelet-codecs the effective mechanism of motion compensation as it is made for standards MPEG for the present is not developed, therefore such codecs usually work in standard MJPEG-2000, where everyone image-frame

of videostream is processed and compressed separately, and output videostream consists of a set of static images (keyframes), as shown in Fig.1.23., in which intraframe redundancy is eliminated only [17].



Fig. 1. 22. Comparative quality of images on the basis of JPEG and JPEG-2000 at Cr=100



Fig. 1. 23. The frame transfer order in MJPEG-2000.

On the one hand, at identical quality of images it allows to receive compression rate in 1.5-2 times more than the single frame (keyframe) in MPEG, but with reference to video stream, wavelet-codecs considerably concede to them on total compression rate due to absence of motion compensation, which provides the basic compression in MPEG-codec. Basically, wavelet transformations can be applied not to the whole image, but to its fragments or blocks, to which it is possible to apply a method of motion compensation, but such splitting into blocks will lead to occurrence of block distortions, and with more expressed borders, due to mismatch number of samples with a length of wavelet-filter on borders of blocks. Therefore it has been carried out research on estimations of videostream compression efficiency by the wavelet-codec at use of an interframe difference of the next frames. For this purpose 2 algorithms were investigated. The first is based on formation of the interframe difference of the adjacent frames, and the second – using logic operation "exclusive OR", as shown in Fig.1.24. For an estimation of interframe difference efficiency in wavelet-codec of format JPEG-2000 experimental researches of videosequences compression from 10 frames of 3 various plots, in which the first frame was compressed as basic (keyframe) with elimination of intraframe statistical redundancy, and the others 9 with an interframe difference, were spent. Results of images processing are shown in comparative Tables 1-3 and presented in the form of graphic in Fig.1.25.

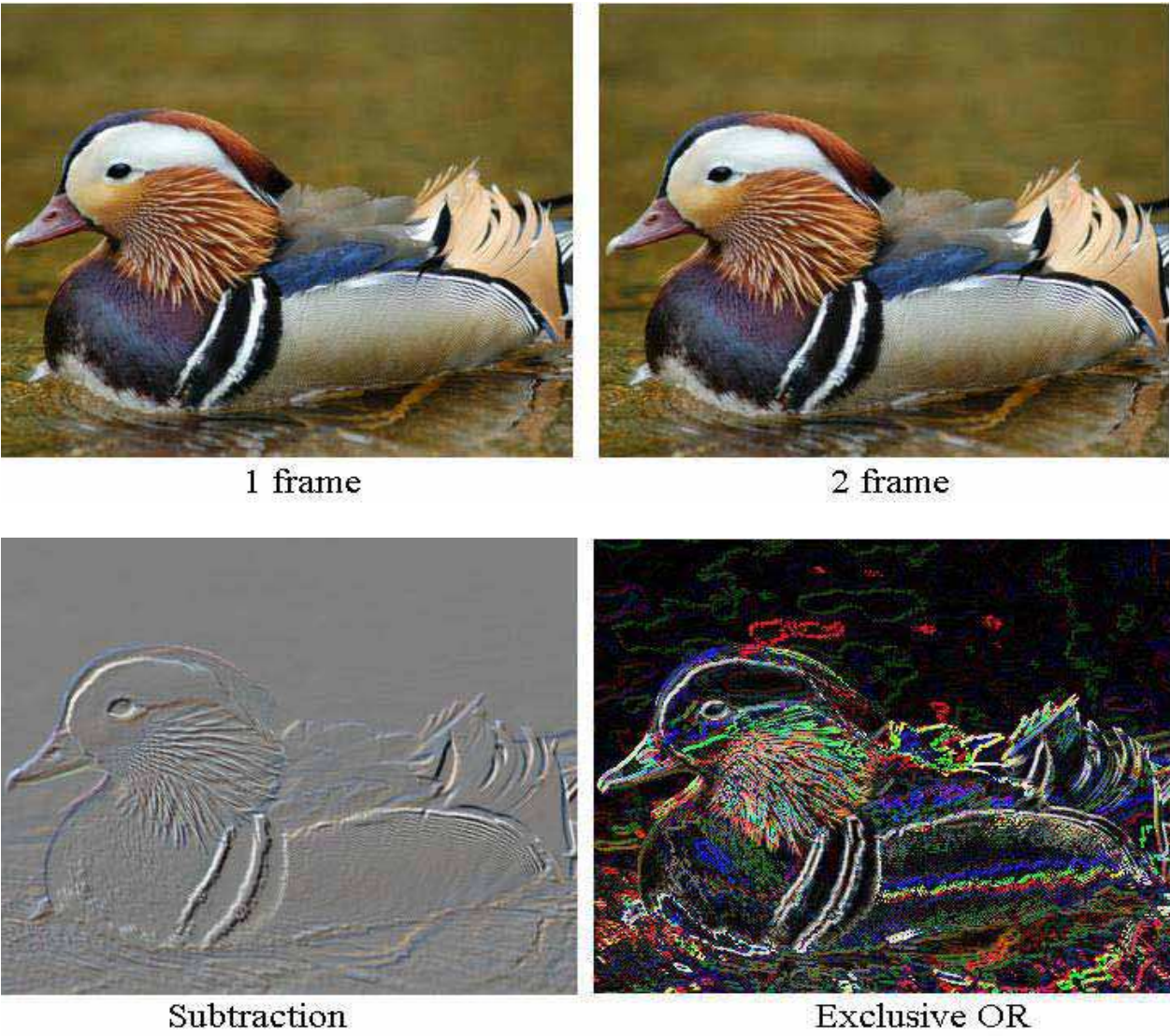


Fig. 24. Formation of interframe difference image on a method of subtraction and logic operation "exclusive OR".

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TABLE 1

Results of compression by codec MJPEG-2000 of 1 frame with dimensions 510x265 and size of 406 KB

№ frame	0	1	2	3	4	5	6	7	8	9	Σ
Frame size, KB											
Lossless compression	33.1	33.6	34.5	34.3	34.7	35.3	34.8	34.6	34.6	31.1	340.6
Compression -20	20.4	20.4	20.4	20.4	20.2	20.2	20.4	20.2	20.4	20.4	203.4
Compression -50	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	81
Compression -100	4.2	4.2	4.2	4.2	4.1	4.2	4.2	4.2	4.1	4.1	41.7

TABLE 2

Results of compression of 1 frame with an interframe difference and method of subtraction											
Nº frame	0	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	Σ
Frame size, KB											
Lossless compression	33.1	11	10	9.6	9.4	9.4	10	10.4	10.5	10.5	123.9
Compression -20	20.4	11.1	10.1	9.6	9.5	9.5	10.1	10.5	10.6	10.5	111.9
Compression -50	8.1	8.0	8.0	8.1	8.0	8.0	8.1	8.1	8.0	8.0	80.4
Compression -100	4.2	4.2	4.1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	41.9

TABLE 3

Results of compression of 1 frame with an interframe difference and "exclusive OR" method											
Nº frame	0	0⊕1	1⊕2	2⊕3	3⊕4	4⊕5	5⊕6	6⊕7	7⊕8	8⊕9	Σ
Frame size, KB											
Lossless compression	33.1	222.8	219.3	218.2	221.2	222.9	224.4	226.6	223.6	217.9	2030
Compression -20	20.4	29.3	29.4	29.4	29.3	29.3	29.4	29.3	29.4	29.4	284.6
Compression -50	8.1	8.1	8.0	8.0	8.1	8.1	8.1	8.1	8.1	8.1	80.8
Compression -100	4.2	4.2	4.2	4.2	4.2	4.2	4.1	4.2	4.1	4.2	41.8

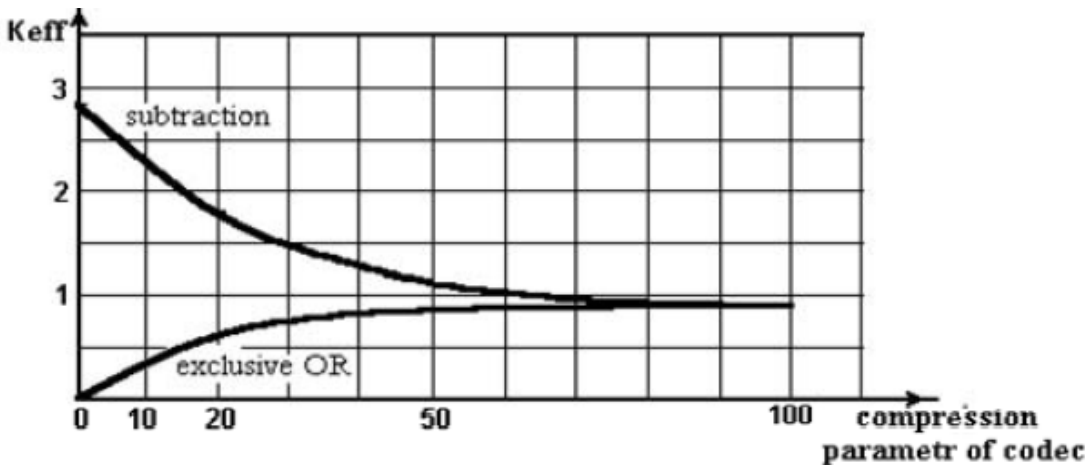


Fig. 1. 25. Dependence of videostream compression efficiency on a method of interframe difference calculation at various wavelet-codec parameters of compression.

Apparently from results of researches, application of an interframe difference gives a positive effect only at small compression rates (10-20 times), and then efficiency falls up to 1, as in an interframe difference high-frequency components which are compressed badly prevail. Especially it is strongly expressed at formation of an interframe difference on a method "exclusive or ", as in this case there is a modification of correlation between samples. Thus, as a result of the lead researches, it is established, that use of an interframe difference at greater compression rates doesn't improve videostream compression efficiency in the wavelet-codecs, therefore works on elimination of interframe redundancy of images for wavelet transformations will be continued.

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This book tries to address different aspects and issues related to video and multimedia distribution over the heterogeneous environment considering broadband satellite networks and general wireless systems where wireless communications and conditions can pose serious problems to the efficient and reliable delivery of content. Specific chapters of the book relate to different research topics covering the architectural aspects of the most famous DVB standard (DVB-T, DVB-S/S2, DVB-H etc.), the protocol aspects and the transmission techniques making use of MIMO, hierarchical modulation and lossy compression. In addition, research issues related to the application layer and to the content semantic, organization and research on the web have also been addressed in order to give a complete view of the problems. The network technologies used in the book are mainly broadband wireless and satellite networks. The book can be read by intermediate students, researchers, engineers or people with some knowledge or specialization in network topics.

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