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Original Scientific Paper

SYSTEM DESIGN AND PROCESS FOR DATA TRANSMISSION THROUGH MULTIPLEX TRANSMITTER CHANNEL, MODULES AND APPLICATION

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Abstract

There is often a need to realize the design of a system that will be stable in data transmission. However, the process of modeling and structuring such a system is a process that initially requires data collection. Then, there is a need to recognize the working environment, as well as to know the problems that may appear in the broadcast. In this paper, there are provided and presented some appropriate models for data transmission based on the type of data (textual data, audio, video, etc.) in accordance with their frequency. In order to realize this system, initially several initial processes, calculations for possible obstacles, calculating the signal-noise ratio (S/N) are realized. The signal-noise ratio is explored based on some probabilistic calculations and so on. Then, in the work, the design of the system is conducted. To design this system, some advanced techniques are provided, which provide the possibility of managing and interconnecting the elements between themselves, through a multiplex system, and so on. All these processes are carried out on the basis of calculated, verified and validated values, to be adequate in the process of data transmission through a single channel, according to a certain bandwidth. Here is a characteristic is, that during this process can also be determined the data packing, the capacity of the transmitter channel; the speed of data transmission, etc. Designing this system is the ultimate stage of the completion of this project. Designing the multiplex system requires elements and other devices that have the task to create the respective module. Also, an integral part of this interconnection and data transmitter system are clock generators; to create relevant frequencies for all elements of the system, from particular elements but integrated into the general system.

Keywords: Design, system, data transmission, channel, multiplex, modules.

1. Introduction

The digital broadcasting is about transmitting discrete information, e.g information expressed by different binary codes through digital signals. All modern broadcasting systems are based on digital broadcasting. Discrete information, namely digital signals, can be generated from any digital device e.g computer, printer, teleprinter, etc., or obtained by digitizing continental signals. An analog signal is termed a signal when its power (amplitude) continuously receives any value between a minimum and a maximum. This is about all real processes and situations. In theory, it is possible to record any small signal change (very large dynamic perimeter).

During processing, problems usually occur through the noise and nonlinearity of the measurement converter during the detection of analog stored signals or transmission through excessive interference accumulation. Depending on the target it may be to convert to more efficient digital signals - e.g. in storing music, transferring data over long distances - or inefficiently, e.g. long memory or critical systems, where conversion would take too long or be highly susceptible to errors due to analog-to-digital conversion. In this paper, "System design process for data transmission through multiplex transmitter channel and modules" is analyzed. During this process the signal to noise ratio, the type of signal, and other effects that affect the signal distortion, and the loss of eventual source and original information, are taken into account.

1.1 Analog signal details and transmission effects

By analog signal we usually mean an electrical signal, in most cases the electrical voltage or current etc. In the next step is given the types, of the analog signals and type of transmission system:

- Analog signals from mechanical, pneumatic, hydraulic and other systems.
- Any information can be transmitted via analog channels, often as a reaction calculated on changes in physical phenomena, such as light, temperature or pressure, which are captured by a single sensor.

Thus e.g. during analog sound recording, the suppressive oscillation of a sound, captured by a microphone, causes oscillation that is related to the created modulation voltage. An increased suppression of the change of sound creates an even higher voltage during the same "rhythm".

The main disadvantage of analogue signals is the random fluctuations, which inevitably occur because no system works smoothly, and which, unlike digital signals, cannot be corrected with the help of verification bits. This applies: the more often a signal is duplicated, or the longer the signal path is, the more the rusting signal will prevail. These signal losses and (distortions) the signal are irreversible because a signal amplification would add even more noise.

Another method for transmitting analog signals is modulation. Here a property of a carrier signal is changed (eg a sinusoidal wave).

During amplitude modulation the amplitude of a voltage in the form of a sine wave is modified through source information, and in frequency modulation the frequency of the carrier signal changes. The third possibility of modulation is phase modulation, at which the phase of the initial signal is reproduced.

1.2 Effect of digital signal and process PCM (pulse code modulation)

In the history of electrical communication is known as the telegraph (TDM-Multiplexing in Time) that enabled the transmission of the signal as early as 1853 by the American discoverer Moses G. Farmer. Then in 1903 the electrical engineer W. M. Miner used the commutator to multiplex the 'telegraphic' signal that was also used in telephony.

The first digital transmission of sound was the SIGSALY vocoder encryption that was used at high levels of communication, while the continuator of this technique Ferranti Canada in 1949 built the PCM radio system that was in use.

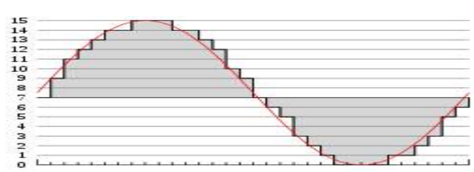

Figure 1. Sampling and quantization of the signal for 4-bit PCM

1.3 The process of modulation and demodulation and their applications

In analog modulation, the main signals are the analog signals, namely the continuous-time continuum signals. The continuous (continuous) signal x (t) is a function of the continuous variable t. If besides the variable t, the signal values also belong to real numbers, then this signal is called the analog signal. Alternatively, the signal may be continuous at t, but discrete at values. In this case, the signal values belong to a numerable set, not to real numbers.

The discrete signal x [n] is defined only for discrete values of time n, which means that n receives values from the set of integers.

While in the continuous signal the time has units in seconds, in the discrete signal the discrete-time n is the term of the signal term and is unit-free.

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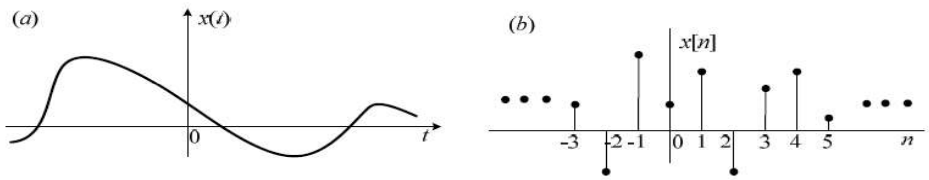

Figure 2. Graphical representation of continuous signal (a) and discrete signal (b)

The discrete signal can be obtained from the analog signal by separating its values at uniform intervals of time.

Only one element of the discrete signal x [n], for example, x [-1], is called the sample. Digital Signal: If the discrete signal values are quantified by taking values from a finite set of numbers then such discretized signal not only in time but also in values is called digital (digit) signal.

1.4 Signal transmission process, energy, and power for continual and discrete signal

When transmitting signals in certain directions, it is understood that the signals carry energy and power. These directions may be different, for example,

- Cable broadcasting.
- Transmission of signals to the motherboard of the computer,
- Short and long-distance signal transmission,
- Signal transmission through various mediums:
  - Wired and wireless broadcasting,
  - Satellite broadcasting
  - Transmission by electromagnetic waves, microwaves, radio waves
  - The transmission of signals through optical fibers etc.

The energy (E) of the continuous signal x (t) is defined by the formula:

$$E = \int_{-\infty}^{\infty} |x(t)|^2 \, dt \qquad (1)$$

While the continuous signal power (P) is expressed by the relation:

$$P = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} |x(t)|^2 \, dt \qquad (2)$$

For discrete signals the following expressions shall apply:

Energy for discrete signals,

$$E = \sum_{n=-\infty}^{\infty} |x(n)|^2 \qquad (3)$$

Power for discrete signals,

$$P = \lim_{N \to \infty} \frac{1}{2N+1} \sum_{n=-N}^{N} |x[n]| \qquad (4)$$

If the signal has finite E energy, then it enters the class of energy signals. If the signal has finite P power, then it belongs to the power signals.

Energy and power are the characteristic physical size of the signal, both for continuous and discrete signals.

- The energy signals have zero power, P = 0.
- Power signals have infinite energy, $E \to \infty$.
- It cannot happen that the signal is both energy and power.
- Whereas, it may happen that a signal is neither energy nor power.
- Periodic signals can only be power signals.

Their power is calculated within a period with the expressions:

Power for continuous signals and discrete signals,

$$P = \frac{1}{T} \int_0^T |x(t)|^2 \;, P = \frac{1}{N} \sum_{n=0}^{N-1} |x[n]|^2 \qquad (5)$$

Where T and N are the basic periods of the continuous, respectively discrete signal.

2. Practical aspects and results of multiplexer, and module system design

For example, a signal frequency band is 30 KHz, 6 signals with frequency bands from 6.5 KHz and two signals with frequency bands from 3.5 KHz, in the TDM multiplex signal form. To transmit data, is used two multiplexers; M=12 channels and $f_{sM} = 16\ KHz$, and the next multiplexer M=2 channels and $f_{sN} = 8\ KHz$. Our aims and task is to find; details as follows:

- Presentation of two multiplex signal- frames
- Block scheme of the multiplexed system
- The speed of the multiplexed signal
- Frequency bandwidth - basic generation system.

For an analysis of this system, is needed to assign the number of channels for signals.

Table 1. Information about the number of channels by Nyquist criterion

Signal	Maximal frequency	Nyquist criterion	Acquired the following values:	The number of channels
M1	$f_{m1} = 30KHz$	$f_{s1} > 2f_{m1} = 2x30KHz = 60\ KHz$	$f_{s1} = 64\ KHz = f_{sM}$	64/12=4 channels
M2, M3, M4, M5, M6, M7	$f_{m2} = f_{m3} = f_{m4} = f_{m5} = f_{m6} = f_{m7} = 3.1\ KHz$	$f_{s2} > 2f_{m2} = 2x6.5KHz = 13KHz$ $f_{s2} = f_{s3} = f_{s4} = f_{s5} = f_{s6} = f_{s7} = 6.2\ KHz$	$f_{s2} = f_{s3} = f_{s4} = f_{s5} = f_{s6} = f_{s7} = 16\ KHz = f_{sM}$	$\frac{16\ x6}{16} = 6\ channel$
M8, M9	$f_{m8} = f_{m9} = 3.5\ KHz$	$f_{s8} > 2f_{m8} = 2x3.5KHz = 7\ KHz$ $f_{s8} = f_{s9} = 8\ KHz$	$f_{s8} = f_{s9} = f_{sN} = 8\ KHz$	$\frac{1}{2} + \frac{1}{2} = 1\ channel$

The order of packets according to the type of signals is shown in the following scheme:

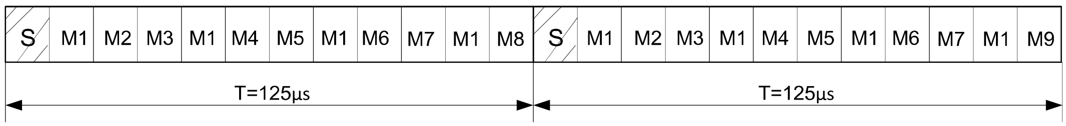

Figure 3. The appearance of the packages, ordered according to the type of signals, where M1…M9 are the signals

The scheme in the Fig.3 represents the packages for corresponding signals M1 ... M9, according to their respective frequency. The schemes describe and present an organization of the packages according to their frequency band. The purpose of this scheme is to do the model for signal transmission through the multiplexed system; namely through the same channel can be transferred more signals of different types.

2.1 The block scheme of the multiplexed system and application

The block schema of the multiplexed signal is:

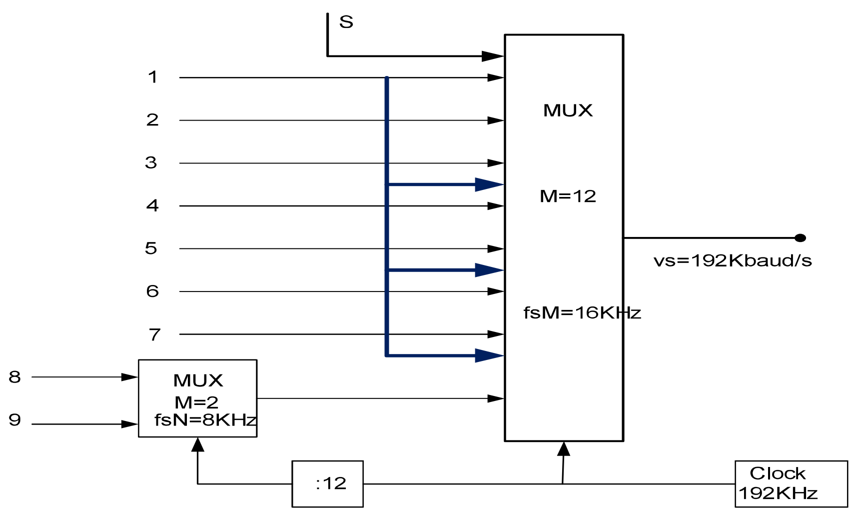

Figure 4. Block scheme of multiplexed system, M=12 channel, fs=16 KHZ, and, M=2 channel, fsN=8KHZ

The speed of the multiplexed signal is calculated by the formula $v = Mf_{sM} = 12 \cdot 16 = 192\frac{kbaud}{s}$

Frequency bandwidth $v = Mf_{sM} = 12 \cdot 16 = 192\ KHz$. $B_m = \frac{v}{2} = \frac{192}{2} = 96\ KHz$-is the frequency bandwidth of the transmission system in the basic band.

Table 2. Calculations and resuslt for differenlty frequency and channel

	Nyquist Frequency	Frequency KHZ	Number channel
1	fs1	16	1
2	fs2	16	1
3	fs3	16	1

4	fs4	16	1
5	fs5	16	1
6	fs6	16	1
7	fs7	16	1
8	fs8	16	1
9	fs9	16	1
10	fs10	16	1
11	fs11	8	0.5
12	fs12	8	0.5
Signal for synchronization			**1**
M=12 channel (-S)			11
Total channel			**12**

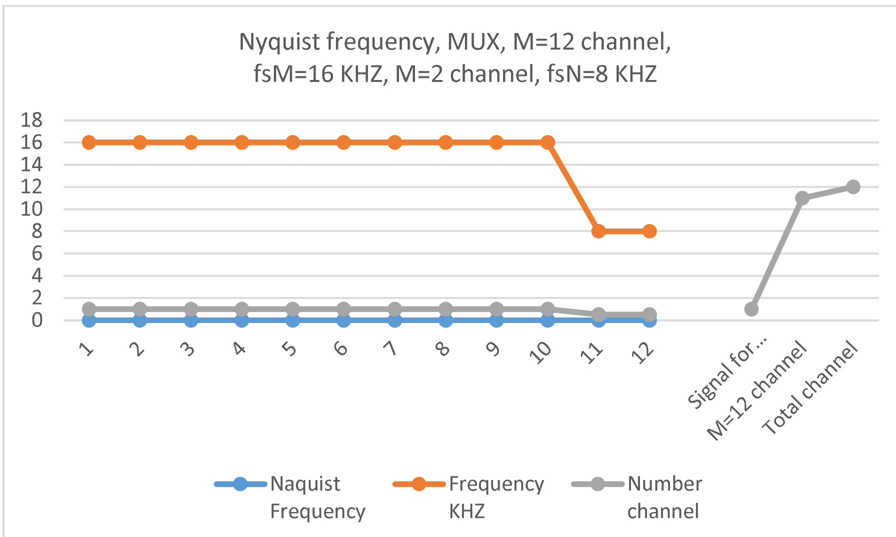

Figure 5. Graphical representations of the Nyquist frequency, MUX, M=12 channel, fsM=16 KHZ, M=2 channel, fsN=8 KHZ

In the next table 2, is given, the distribution of the speed multiplexed signal in the respective multiplex systems, with M=12 channel, and 16 KHZ. Also, is presented the position of the total channel, with corresponding frequency bandwidth in the multiplexed system.

Table 3. The speed of the multiplexed signal, and the freuency bandwidth

	M Number of channel	Fsm Nyquist frequency	v-The speed of the multiplexed signal (kbaud/s or KHz)	Bm The frequency bandwidth of the transmission system (KHZ)
1	1	16	16	8
2	2	16	32	16
3	3	16	48	24
4	4	16	64	32
5	5	16	80	40
6	6	16	96	48
7	7	16	112	56

8	8	16	128	64
9	9	16	144	72
10	10	16	160	80
11	11	16	176	88
12	12	16	192	96
...	..	...	...	...

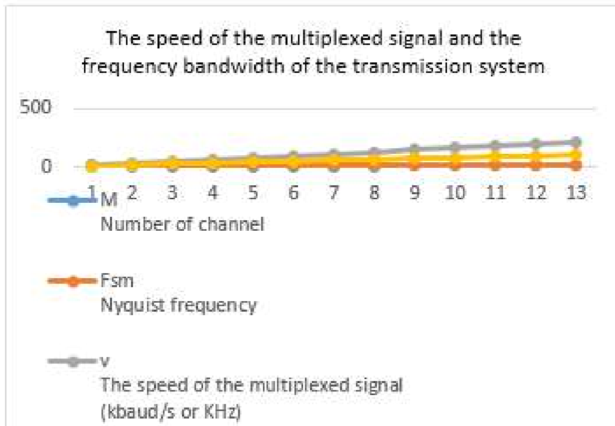

Figure 6. Graphical representations, the speed for the multiplexed signal, and bandwidth

3. Conclusions

This paper aims to analyze multiplexed systems and designing the respective modules and also is given some results for this system. The process for the signal digitization process and the analog signal discretization process in time, known as the sampling process; the analog signal at certain intervals receives the signal values. In the paper is used the Najquist criterion, is a prerequisite for the possibility of returning the information signal to the receiver. Then, due to the reduction in the number of symbols, the quantization process is performed which enables the amplitude of the sampled signal to be limited. After the quantization process, the final procedure is known as coding, where each level of quantization is accompanied by a series of rectangular pulses of a certain duration where each such pulse is known as a bit. Demodulation- this procedure represents the inverse modulation function where at the receiver the signal must be restored to its original form. As a way of accomplishing the creation of the original signal of the input signal at the receiver we have the decoder that achieves the detection of the signal value, then with a low-frequency filter is achieved to restore the information signal. But one must keep in mind the Najquist criterion for sampling which is a prerequisite so that the modulated signal can be restored to its basic form. As is expressesed in the abstract, also here is designed the multiplex system that requires elements and other devices that have the task to create the respective module.

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