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## The Implementation of the Hamming Codes for Sending Information

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Sending data is considered by everybody the main link in what we may usually call information technology. More correctly we may say it is about the information science. The apparent dichotomy from this combination of words "information and data transmission" suggests in fact the theoretical substantiation: the information theory from which derives/results the main application: data transmission (at distance).

For the moment we shall consider that data transmission means only one sense of the information transfer from a source to the user, while the communication means the information transfer between two equipments (terminals) both ways. Thus, because usually the transfer channel is used bidirectional, we are going to call it from now on channel of communication and we'll use for the ensemble providing the change of information the name of system of communication.

The technological progresses: transducers, integrated circuits, microprocessors, laser, satellites of communication made possible that the developed communication systems to allow the transmission wherever in the world of any kind of information: voice, text, drawings, images, etc.



In the mean time, the present industrial époque means the improvement of the industrial processes automation and possibilities to control them by the computer. This development showed the necessity of communication between different intelligent equipments and the calculation/counting system and also between equipments (machines) and the human operator.

The kind of the sent information has developed so that symbols are used in the discrete technique thus it has been replaced the analogical measurement technique of sending information.

## The Implementation of the Hamming Codes Using the Matlab Program

Matlab is a very high level language presenting important performances from the point of view of the technical calculation (Matlab represents a shortcut of the words “Matrix Laboratory”). Beside the control interpreter are presented tools such as those for visualizing data, sounds and images, electrical circuits analyze, etc.

**Notions/Details about Simulink Library.** Simulink is a package of programs for modeling, simulation and analyze dynamic systems. It may be simulated linear and non linear systems during ongoing shaping , discrete or in a combination of the two. The systems may have parts with different sampling frequencies.

### Hamming Codes

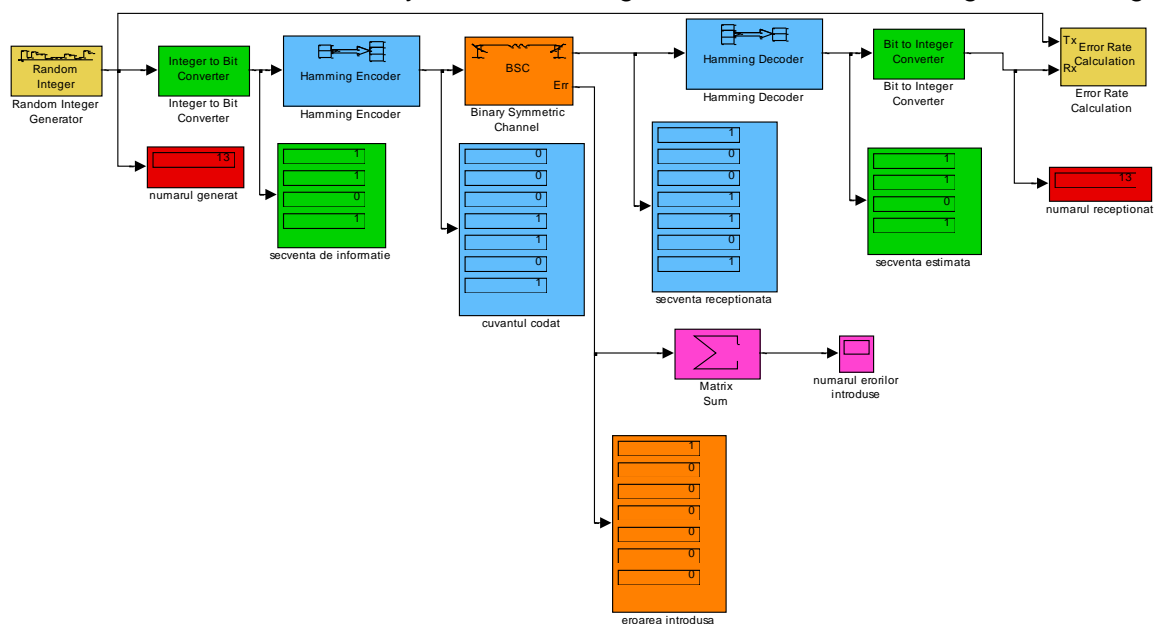
Hamming Codes represent a special category of the block codes correcting errors. These codes and their derived variants are largely used for correcting errors in digital communications and in data storage systems.

For any positive whole  $m \geq 3$  exists a Hamming code having the following parameters:

- length of the code  $n = 2^m - 1;$
- number of the information symbols:  $k = 2^m - m - 1 ;$
- number of the control symbols:  $n - k = m;$
- correction capacity:  $t = 1(d_{\min}=3)$

**Applications Hamming codes.** Hamming codes are a part of block codes. These codes are perfect codes, correcting errors, correcting all the simple errors structures but no combination of double errors, detecting all the error structure one or two errors.

In order to show the utility of the Hamming code we use the following model/design:



Scheme made in Simulink for Hamming code



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We are using the following blocks:

- **Random-Integer Generator:** generating integers numbers distributed in the interval (0,M-)  
The parameters of the block are:
  - "M-ary number" is  $2^4$  because the Hamming used code is C(7,4) and numbers generated are binary represented on 4 bit,
  - "Initial seed" is 12345. Modifying this parameter is modified the generated number sequence.
  - "Sample time" is 1. Generates one number each second.
  
- **Integer to Bit Converter:** transforms a vector of integers in a vector of bit.  
The block parameter is:
  - "Number of bit per integer" is 4
  
- **Hamming Encoder:** creates a Hamming code from the binary vector.  
The block parameter are:
  - "Codeword length N" is 7.
  - "Message length" is 4 because is used the code C(7,4).
  
- **Binary Symmetric Channel:** introduces binary errors.  
The parameters of the block are:
  - "Error probability" is 0.29 for introducing one error.
  - Input vector length" is 7 because the code word added is represented on 7 bit.
  - "Initial seed" is 1234.
  - "Sample time" is 1 to generate a sample at each second.
  
- **Hamming Decoder:** decoders a Hamming code to restore the sent binary vector.  
The block parameters are:
  - "Codeword length K" is 7.
  - "Message length K" is 4 because the used code is C(7,4).

The implementation of the Hamming codes and its derived variants contributes/allow the error corrections in digital communication and in the data storage systems.