Channel Coding Theorem - I

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Level of Reliability

- The inevitable presence of noise in a channel causes ***discrepancies (errors) between the output and input data sequences*** of a digital communication system.
- For a ***relatively noisy channel***, (e.g. wireless communication channel) , the probability of error may reach a value as high as $\mathbf{10^{-1}}$. which means that (on the average) only 9 out of 10 transmitted bits are received correctly.

Need of Channel Coding

- For many applications, this level of reliability $\mathbf{10^{-1}}$ is unacceptable.
- A probability of error equal to 10^{-6} or even lower is the necessary requirement.
- To achieve such a high level of performance, we use the ***channel coding***.

Design Goal of Channel Coding

- To increase the resistance of a digital communication system to channel noise.

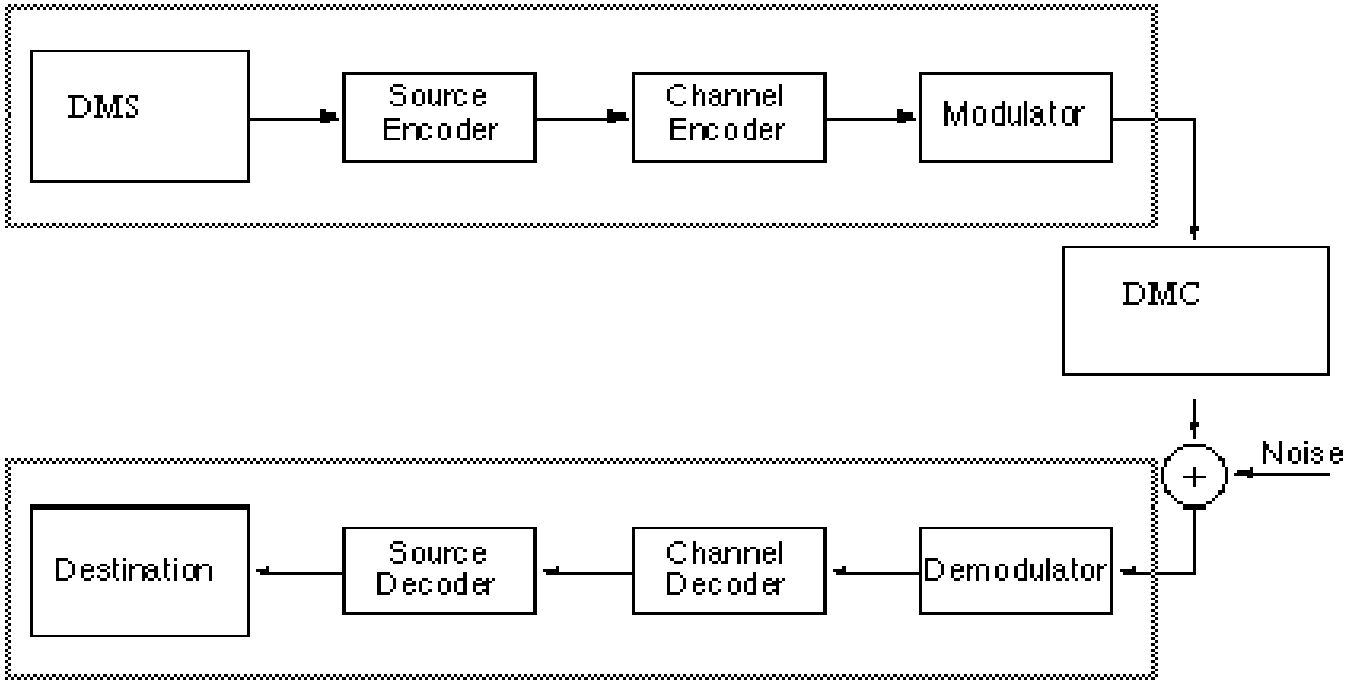
Channel Coding Operations

- Involves two operations:
  - **Mapping** the incoming data sequence into a channel input sequence (at transmitter).
  - and **inverse mapping** the channel output sequence into an output sequence (at receiver) *in such a way that the overall effect of channel noise is minimized*.

Channel Encoder and Decoder

- The first mapping operation is performed in the transmitter by a ***channel encoder***.
- The inverse mapping operation is performed in the receiver by a ***channel decoder***.

Block Diagram of Digital Communication System



Design of a Channel Encoder and Decoder

- Need:
  - To optimize the overall reliability of the communication system.
- Design Principle:
  - Introduce redundancy in the channel encoder so as to reconstruct the original sequence as accurately as possible at the channel decoder.

Channel Coding Vs Source Coding

- Channel coding ***introduces controlled redundancy to improve reliability***.
- Source coding ***reduces redundancy to improve efficiency***.

Block Codes

- Most popular channel code is ***block code***.
- Principle:
  - The message sequence to be transmitted thru the channel is first subdivided into a number of (sequential) blocks each having the length as same (assume k bits).
  - i.e. each k-bit block is mapped into an n-bit block, where n>k.
  - The number of redundant bits added by the channel encoder to each transmitted block is n-k bits.

Code Rate (r)

- The ratio k/n is alos called the code rate denoted by r.

$$r = k/n$$

  - r is less than unity.
  - When the block length n approaches ∞ , the code rate reaches zero., therefore the coding efficiency η approaches zero.