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ISIT2011 ISIT 2011

#1569420679: *Capacity of Gaussian Channels with Duty Cycle and Power Constraints*

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Conference and *track*		**2011 IEEE International Symposium on Information Theory** - *2011 IEEE International Symposium on Information Theory*

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Presenter		presenter not specified
Registration		+
Category		Eligible for ISIT Student Paper Award
Title		*Capacity of Gaussian Channels with Duty Cycle and Power Constraints*

Abstract

THIS PAPER IS ELIGIBLE FOR THE STUDENT PAPER AWARD. In many wireless communication systems, radios are subject to duty cycle constraint, that is, a radio only actively transmits signals over a fraction of the time. For example, it is desirable to have a small duty cycle in some low power systems; a half-duplex radio cannot keep transmitting if it wishes to receive useful signals; and a cognitive radio needs to listen and detect primary users frequently. This work studies the capacity of scalar discrete-time Gaussian channels subject to duty cycle constraint as well as average transmit power constraint. The duty cycle constraint can be regarded as a requirement on the minimum fraction of nontransmission or zero symbols in each codeword. A unique discrete input distribution is shown to achieve the channel capacity. In many situations, numerical results demonstrate that using the optimal input can improve the capacity by a large margin compared to using Gaussian input, which is capacity-achieving in the absence of the duty cycle constraint. This is because the positions of the nontransmission symbol in a codeword can convey information. The results suggest that, under duty cycle constraint, departing from the usual paradigm of intermittent packet transmissions may yield substantial gain.

Topics		Shannon theory
Session		The program is not yet visible (tpc)
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Review manuscript	PDF	5	265,075	February 15, 2011 18:37:42 EST	ef893c9a88ed511581121405179d33bf	8

Final manuscript		Can upload 5 pages until May 31, 2011 00:00:00 EDT.

Personal notes

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Reviews

You are a TPC member for this conference.

2 Reviews

Review 1 (Reviewer B)

Importance	Technical Level	Novelty	Presentation	Recommendation
Very Important (4)	Extremely high technical level (5)	Very Novel (4)	Good (4)	Strongly Recommend (5)

Comments and Recommendation (Please give the reasoning for your overall recommendation and any additional comments you wish to add.)

This is a very nice paper. I have two comments:

1. Just a thought -- it would be interesting (and perhaps more fair) to compare the performance (e.g. as in Fig. 2) to "coded TDD", i.e., when the positions used for the Gaussian transmission are first coded to carry information. In high SNR this would add ~h_b(q) bits to the TDD Gaussian capacity, and in lower SNRs it should add something like the capacity of a BSC whose crossover probability is determined by the SNR, under input type constraint q. This could be viewed as superposition coding for a suitably defined BC. I wonder how well this scheme performs for reasonable SNRs.

2. The paper "Characterization and Computation of Optimal Distributions for Channel Coding" by Huang and Meyn (IT Trans, July 2005) seems to be relevant, especially from the computational perspective.

Review 2 (Reviewer C)

Importance	Technical Level	Novelty	Presentation	Recommendation
Very Important (4)	Extremely high technical level (5)	Very Novel (4)	Excellent (5)	Strongly Recommend (5)

Strengths (What are the key strengths of this paper?)

This paper investigates the capacity of AWGN channels with both an average power constraint and a constraint on how many non-zero symbols the transmitter can send. The naive strategy would be to use a Gaussian codebook on the available symbols. Interestingly, this is far from optimal. As the authors show, the optimal codebook uses a discrete input distribution. This paper develops the necessary mathematics to show this interesting result. Also, via simulation, the authors characterize that large gains are possible over standard Gaussian inputs. The paper is well-written and provides an interesting story and is a natural fit for ISIT.

Weaknesses (What are the major weaknesses of this paper?)

I did not find any major weaknesses.

Comments and Recommendation (Please give the reasoning for your overall recommendation and any additional comments you wish to add.)

In my view, this is a clear accept to ISIT.

Specific suggestions:

p2: "Without loss of capacity, we assume ... PAM or QAM. I don't understand how this does not lose capacity. How does this possibly include Gaussian inputs? Please clarify this sentence.

Fig1: The probabilities do not sum up to 0.7. I assume this is due to rounding errors.

1 Summary review by TPC member

Review 1 (Reviewer A)

TPC recommendation
Strong accept (5)

TPC Recommendation Justification (Please give a justification for your recommendation, especially if the review scores vary widely or your recommendation differs significantly from those of the reviewers.)

Both reviewers are extremely positive about this paper, and I share their enthusiasm. The problem considered by the authors is interesting theoretically and relevant practically, and the results contain some nontrivial insights -- i.e., the use of discrete signaling under a duty cycle constraint is superior to intermittent Gaussian signaling because the timing of nontransmissions can be used to convey information.

The paper draws interesting connections to the classic results of Smith on the capacity of AWGN channels under peak and average power constraints, as well as to more recent work by Chan et al. on capacity-achieving distributions for conditionally Gaussian channels. The presentation is very clear and precise, and the proofs use an impressive array of tools, from estimation and information theory to complex analysis and optimization theory. Very nice work!

The reviewers bring up some minor issues, but I'm sure the authors will have no problem addressing them in the final version.

Discussion

Not a reviewer.
Apr 16, 2011
04:22

A TPC MEMBER SUBMITTED THE FOLLOWING NOMINATION OF THIS PAPER FOR THE STUDENT PAPER AWARD:
This paper has several distinct strengths, which make it worthy of the student award.

First of all, it deals with an interesting problem and presents an interesting solution. The problem is to characterize the capacity of Gaussian
channels under a power constraint and a duty cycle constraint (i.e., transmissions occur at discrete time instants, and there is a constraint on the
fraction of nonzero transmissions). The solution has some nontrivial insights -- i.e., the use of discrete signaling under a duty cycle constraint is
superior to intermittent Gaussian signaling because the timing of nontransmissions can be used to convey information.

Secondly, the paper draws interesting connections to the classic results of Smith on the capacity of AWGN channels under peak and average power
constraints, as well as to more recent work by Chan et al. on capacity-achieving distributions for conditionally Gaussian channels. The proofs use an
impressive array of tools, from estimation and information theory to complex analysis and optimization theory.

Thirdly, the presentation is clear and precise and avoids unnecessary clutter, which is a bit of a rarity these days.

Overall, both reviewers, who are experts in the area, have given very favorable and enthusiastic assessments of the paper and, quite importantly, did
not point out any specific weaknesses. Instead, they spoke to the paper's numerous strengths. I certainly share their opinion. I have done some work
on Gaussian channel capacity under peak power constraints a few years ago, and I can certainly appreciate the nontrivial theoretical aspects of
problems of this type, as well as their relevance to practical systems.
