On the Design of Stable, High Performance Sigma Delta Modulators

M.A.Sc. Thesis Defence

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Table of Contents

Introduction

Project Objectives

Primary Objective

To develop a systematic method of design for sigma delta A/D converters for the recording of bio-signals.

Ideally, the goals of the method are to:

- Model the nonlinear system accurately in a way that allows analysis of existing designs.
- Reduce dependence on simulation.
- Provide a way to design guaranteed stable sigma delta modulators in a way that minimizes conservatism.

Principles of Sigma Delta Modulation

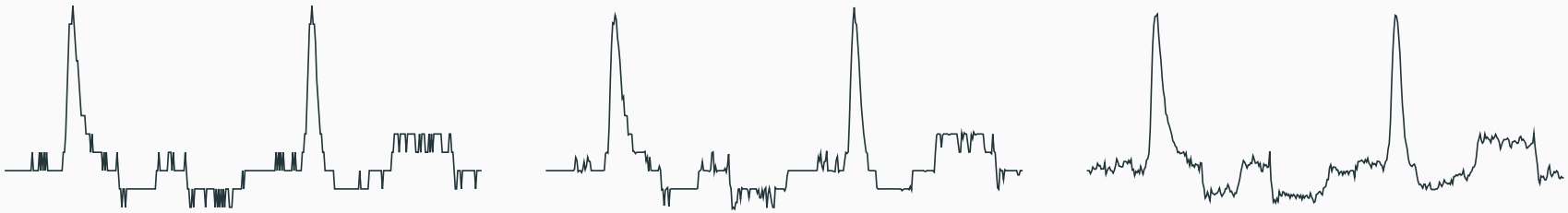

Figure 1: An example EEG signal digitized to 5 bits with naïve quantization (left), 10 times oversampled quantization (middle), and first-order sigma delta modulation (right).

Oversampling

Sampling a signal at a rate higher than what the Nyquist-Shannon sampling theorem would dictate.

Noise Shaping

The use of a filter to push quantization noise out of the signal band by wrapping the quantizer in a feedback loop.

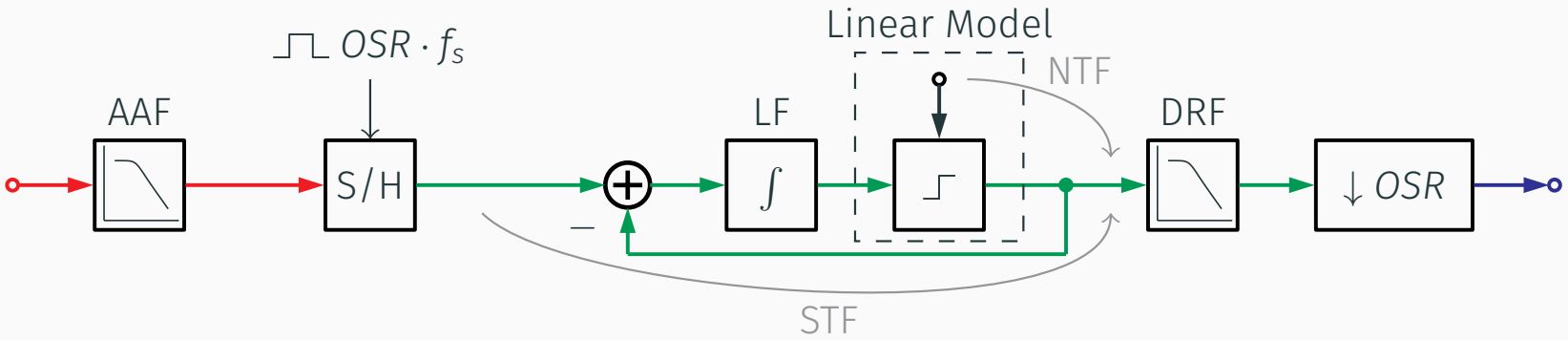

Figure 2: A simplified block diagram of a discrete-time sigma delta A/D converter.

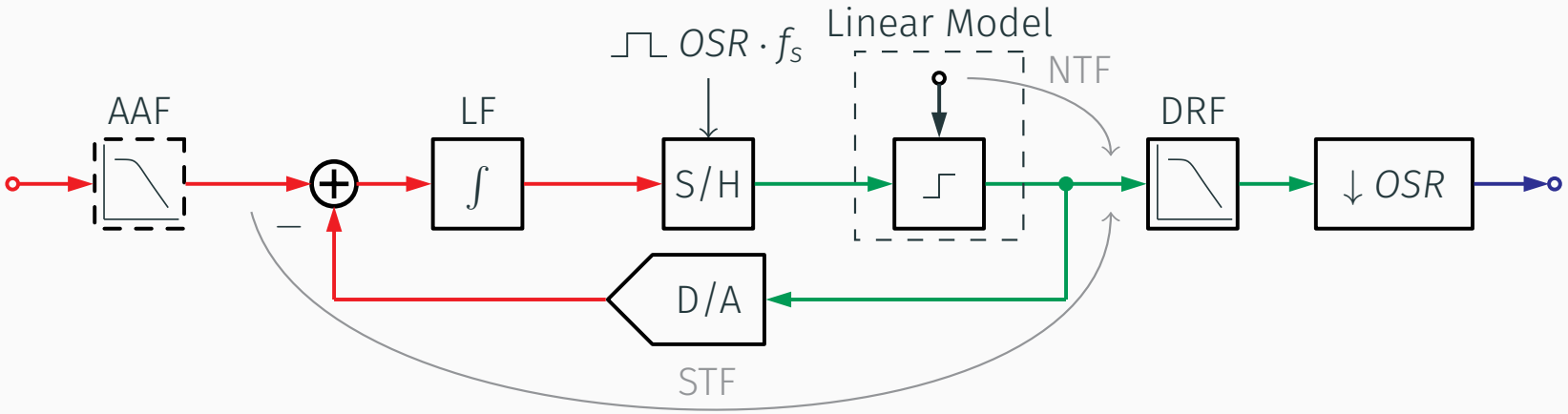

Figure 3: A simplified block diagram of a continuous-time sigma delta A/D converter.

Design of the Loop Filter

The nonlinear quantizer in the forward path makes stability analysis difficult. Loop filter design is commonly done in one of several ways:

- Pure integrator – DC-stable for low order loops.
- Prototype NTF – noise rejection of linear model chosen from a family of filters.
- Optimization-based approaches – wide range of techniques.

The design process often relies on extensive simulation to confirm that stability is likely during normal operation and the circuit may include complicated instability detection and recovery mechanisms.

Sections

Sections group slides of the same topic

```
\section{Elements}
```

for which **METROPOLIS** provides a nice progress indicator ...

Titleformats

Metropolis titleformats

METROPOLIS supports 4 different titleformats:

- Regular
- Smallcaps
- allsmallcaps
- ALLCAPS

They can either be set at once for every title type or individually.

This frame uses the `smallcaps` titleformat.

Potential Problems

Be aware, that not every font supports small caps. If for example you typeset your presentation with pdfTeX and the Computer Modern Sans Serif font, every text in smallcaps will be typeset with the Computer Modern Serif font instead.

This frame uses the `allsmallcaps` titleformat.

Potential problems

As this titleformat also uses smallcaps you face the same problems as with the `smallcaps` titleformat. Additionally this format can cause some other problems. Please refer to the documentation if you consider using it.

As a rule of thumb: Just use it for plaintext-only titles.

This frame uses the `allcaps` titleformat.

Potential Problems

This titleformat is not as problematic as the `allsmallcaps` format, but basically suffers from the same deficiencies. So please have a look at the documentation if you want to use it.

Elements

Typography

```
The theme provides sensible defaults to
\emph{emphasize} text, \alert{accent} parts
or show \textbf{bold} results.
```

becomes

The theme provides sensible defaults to *emphasize* text, accent parts or show **bold** results.

Font feature test

- Regular
- *Italic*
- SmallCaps
- **Bold**
- ***Bold Italic***
- **Bold SmallCaps**
- `Monospace`
- `Monospace Italic`
- **`Monospace Bold`**
- **`Monospace Bold Italic`**

Lists

Items

- Milk
- Eggs
- Potatos

Enumerations

1. First,
2. Second and
3. Last.

Descriptions

PowerPoint Meeh.

Beamer Yeeeha.

Animation

- This is important

Animation

- This is important
- Now this

Animation

- This is important
- Now this
- And now this

Animation

- This is really important
- Now this
- And now this

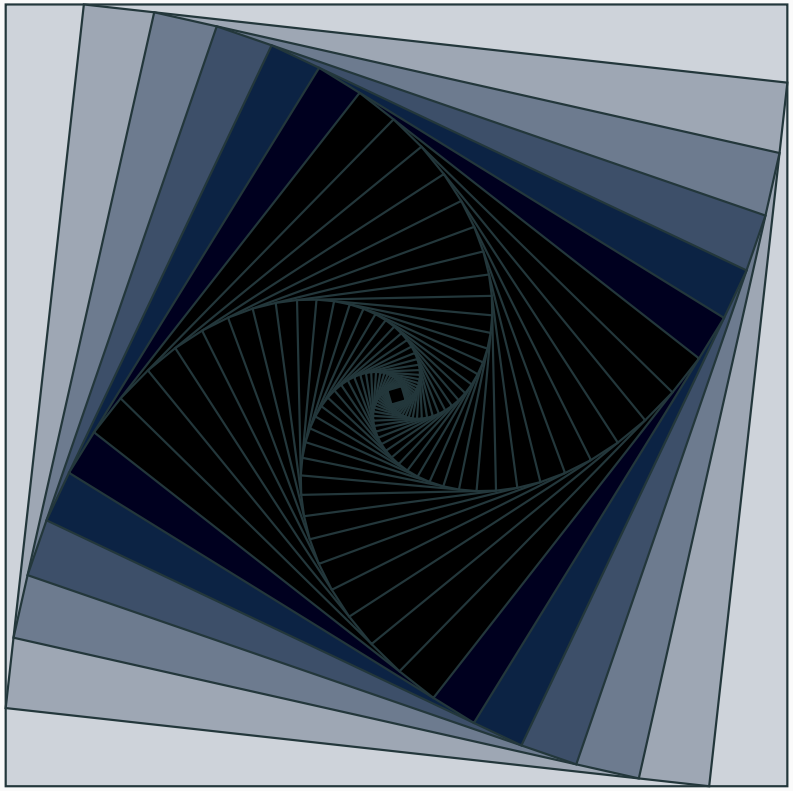

Figure 4: Rotated square from texample.net.

Tables

Table 1: Largest cities in the world (source: Wikipedia)

City	Population
Mexico City	20,116,842
Shanghai	19,210,000
Peking	15,796,450
Istanbul	14,160,467

Blocks

Three different block environments are pre-defined and may be styled with an optional background color.

Default

Block content.

Alert

Block content.

Example

Block content.

Default

Block content.

Alert

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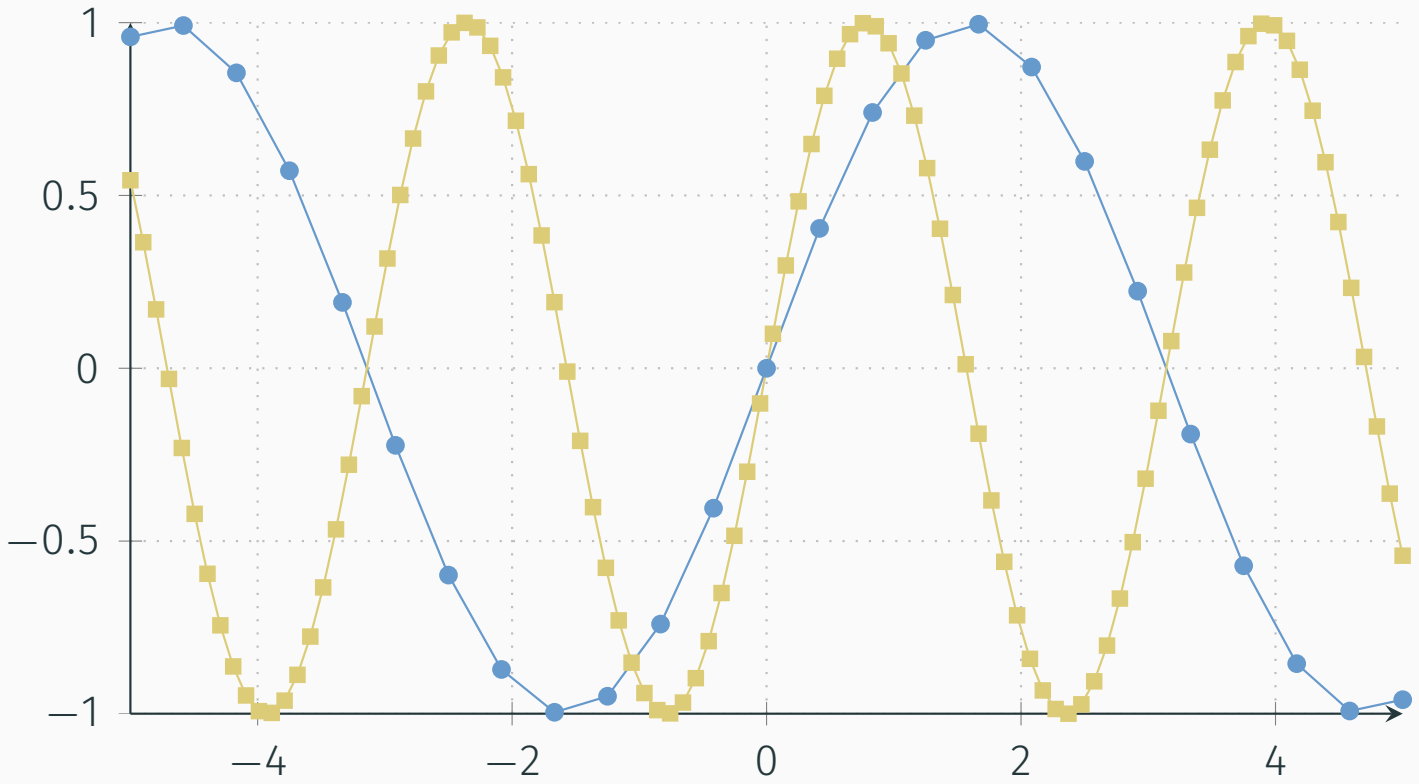
Example

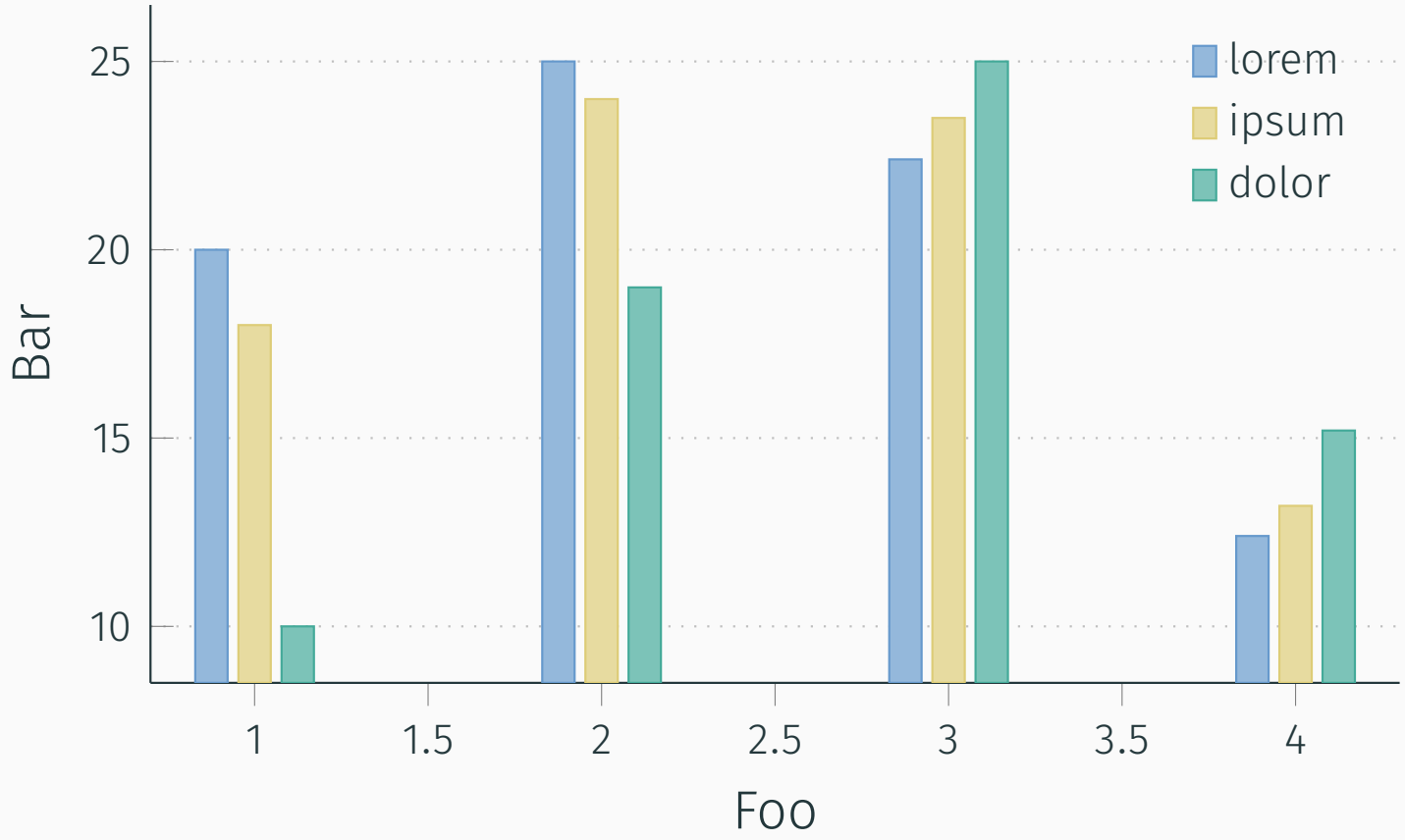
Block content.

$$e = \lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n$$

Line plots



Bar charts



Quotes

Veni, Vidi, Vici

Frame footer

METROPOLIS defines a custom beamer template to add a text to the footer. It can be set via

```
\setbeamertemplate{frame footer}{My custom footer}
```

References

Some references to showcase [allowframebreaks] [**?**, **?**, **?**, **?**, **?**]

Conclusion

Summary

You can view the source on Github

`github.com/JoeyEremondi/UBC-Metropolis-Beamer`

The original theme can be found at

`github.com/matze/mtheme`

Questions?

Backup slides

Sometimes, it is useful to add slides at the end of your presentation to refer to during audience questions.

The best way to do this is to include the `appendixnumberbeamer` package in your preamble and call `\appendix` before your backup slides.

METROPOLIS will automatically turn off slide numbering and progress bars for slides in the appendix.

References i