SI/TI Tools

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SI/TI Overview

- Defined in ITU-T Rec. P.910
- Classify spatiotemporal complexity of video sequences
- Definitions:
  - SI: Standard deviation of Sobel-filtered image
  - TI: A basic motion difference feature for adjacent frames

$$SI = max_{time}\{std_{space}[Sobel(Fn)]\}$$
$$M_n(i,j) = F_n(i,j) - F_{n-1}(i,j)$$

Updates to SI/TI Functions

- Make SI/TI future-proof:
  - Harmonize existing implementations wrt. handling of edges and full/limited range conversions
  - Handle content > 8 Bit per channel
  - Handle HDR content
  - → provide an update for ITU-T Rec. P.910
- Provide an even better encoding complexity metric:
  - Proposal by Ioannis Katsavounidis: Enhancing SI/TI with basic motion compensation
  - Code is available and will should be shared soon

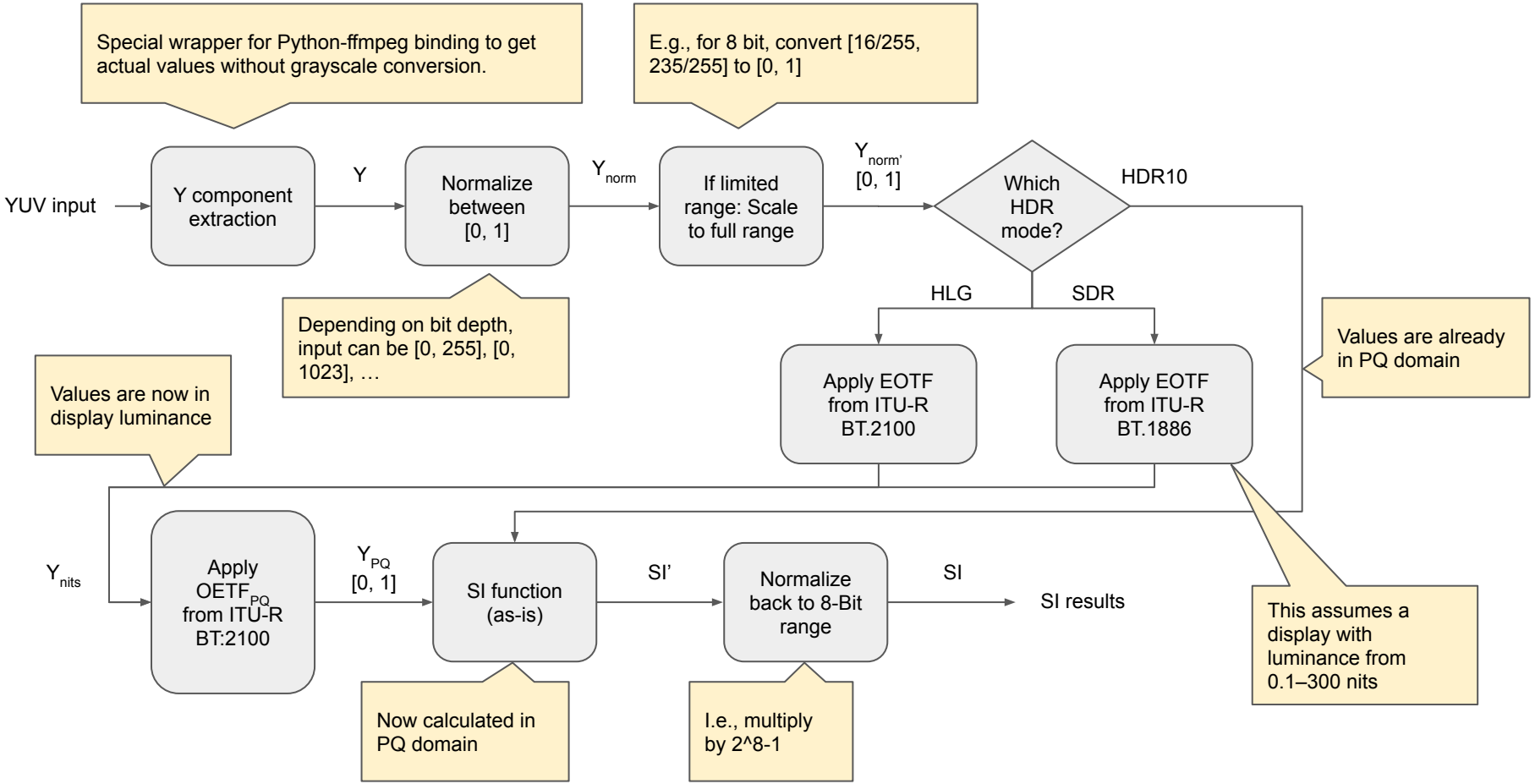
Activities so far

- New software developed:
  - Written in Python (slow, but good experimental platform)
  - Main branch for “stable” version with the “good old” SI/TI: https://github.com/Telecommunication-Telemedia-Assessment/siti-tools/
  - “Siti2020” branch for current updates: https://github.com/Telecommunication-Telemedia-Assessment/siti-tools/tree/siti2020
- Liaison statement to ITU-T Study Group 12, informing them of our activities and inviting contributions

Software Features

- Command-line interface and API
  - Select bit depth, HDR mode, HDR conversion functions and parametrization
- Read y4m container format
  - Chosen for simplicity/interoperability
  - Support for > 8 Bit content is experimental
- Treat frames according to conversion pipeline
  - Pipeline proposed by Lukáš Krasula, including implementations of all conversion functions
- Calculate SI and TI with “good old” functions
- Output to JSON
  - Allows re-using the settings from previous runs to enable reproducible results
- Output to CSV
  - For quick analysis

Demo time!

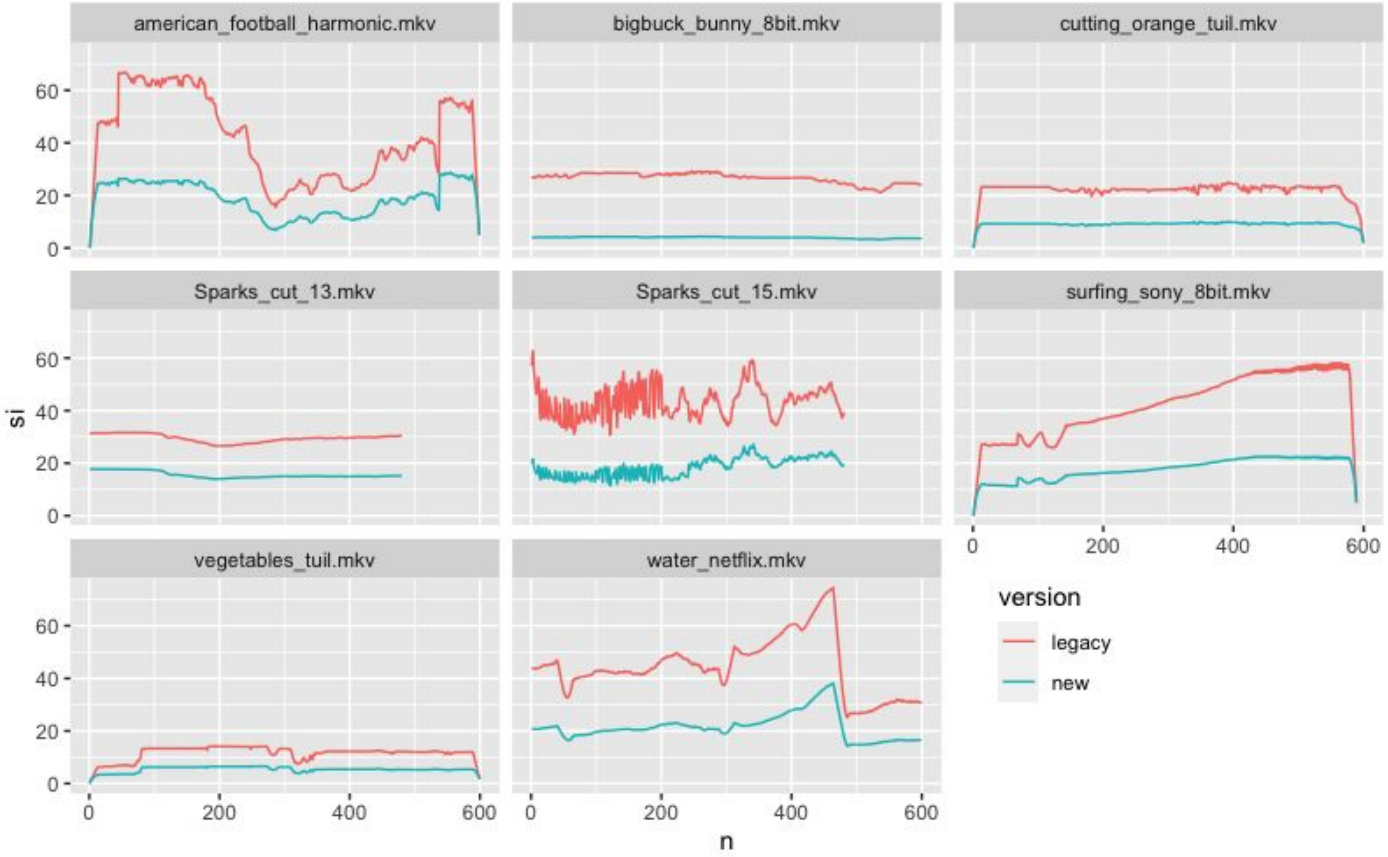

Special wrapper for Python-ffmpeg binding to get actual values without grayscale conversion.
E.g., for 8 bit, convert [16/255, 235/255] to [0, 1]
YUV input
Y component extraction
Y
Normalize between [0, 1]
Y_{norm}
If limited range: Scale to full range
$Y_{norm'}$ [0, 1]
Which HDR mode?
HDR10
HLG
SDR
Depending on bit depth, input can be [0, 255], [0, 1023], …
Apply EOTF from ITU-R BT.2100
Apply EOTF from ITU-R BT.1886
Values are already in PQ domain
Values are now in display luminance
Y_{nits}
Apply $OETF_{PQ}$ from ITU-R BT:2100
Y_{PQ} [0, 1]
SI function (as-is)
SI'
Normalize back to 8-Bit range
SI
SI results
This assumes a display with luminance from 0.1–300 nits
Now calculated in PQ domain
I.e., multiply by 2^8-1

Evaluation

New vs. “legacy” SI/TI on AVT-VQDB-UHD1

10s, 2160p, 8-bit SDR

→ Values are lower due to shift to PQ domain

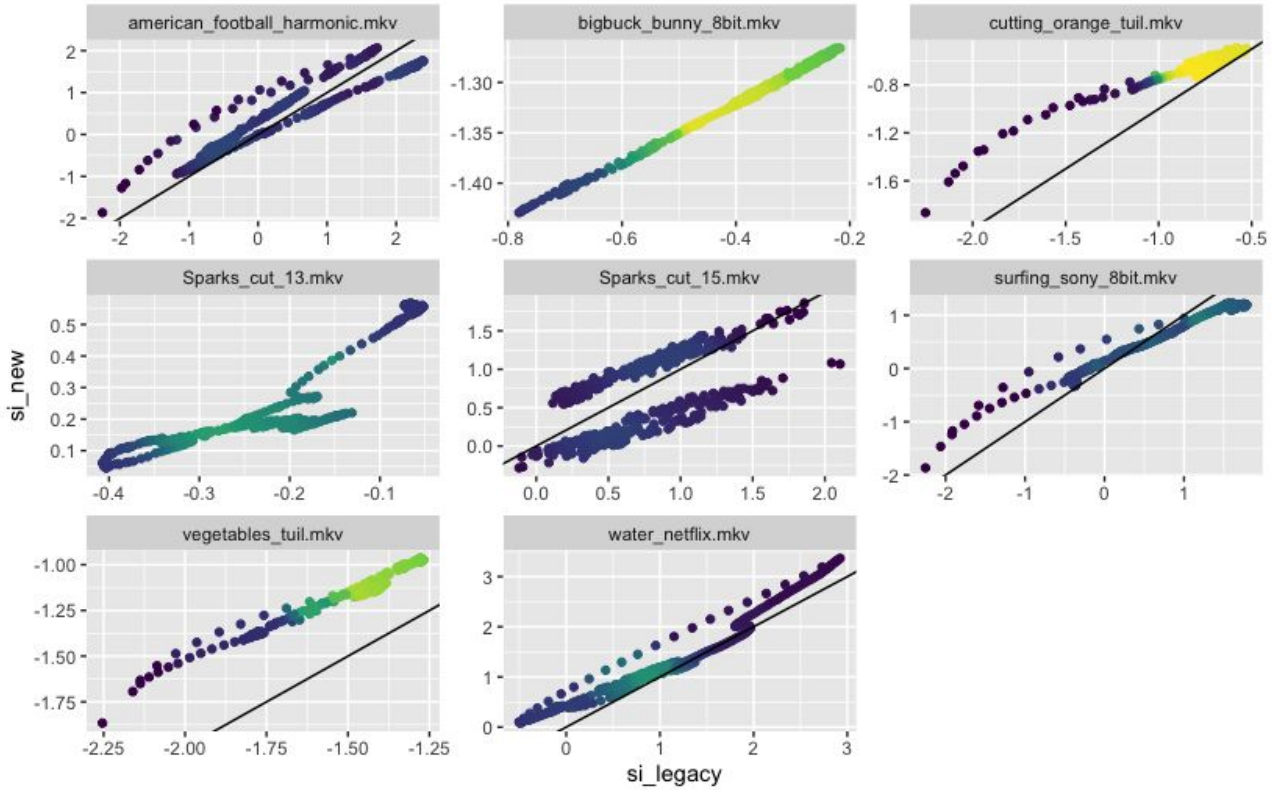


Is it linear?

Z-normalize SI/TI scores per group (legacy/new), i.e. subtract mean, divide by standard deviation

Plot correlation and density (colored) for SI

→ Not just a linear shift



Open issues

- Performance
  - Python implementation a bit slow
  - Possibility to use fixed-point calculations and native C extensions
  - Buffered file reading with parallel computation of SI and TI values (with queues)
  - …
- Range of SI values
  - SI values become lower after running OETF for SDR content, because you are limited to lower range of PQ domain
- Check PU21 domain (as an alternative to PQ)

See:
https://github.com/Telecommunication-Telemedia-Assessment/siti-tools/issues