

# TIK: Temporal Imaging from Kentucky



Ordinary cameras see the world as a sequence of images, each representing the scene appearance averaged over some exposure interval – but we see the world as *inherently continuous*, with scenes smoothly changing over time. Capturing and computationally manipulating a model of these continuous changes in scene appearance is what our TDCI (TIME DOMAIN CONTINUOUS IMAGING) research is all about. TIK (TEMPORAL IMAGING FROM KENTUCKY) is the new, public domain, encoding format and software that makes it practical to do TDCI with conventional cameras.

**What Does The TIK Software Do?** Working from a set of captured still images and/or videos, the TIK software derives a continuous waveform describing how the appearance of each pixel varies over time. Construction and compression of the TDCI waveforms uses a noise model, and TIK also can analyze images and/or videos to create a noise model for a specific camera and capture circumstances. However, the primary thing TIK does is to use a TDCI stream to:

- Render an image for any virtual shutter speed and time interval. The user can nudge the exposure interval forward/backward after capture to get the precise moment with shutter speed set for the desired artistic effect.
- Render movies at any framerate and shutter angle. TIK image data is inherently framerate independent.
- Always obtain HDR (HIGH DYNAMIC RANGE), independent of lighting and virtual exposure time. The estimate of the value of a pixel is not based on a single measurement, but is obtained by numerical integration of the area under the pixel waveform – which is synthesized from multiple samples.

**TIK Is Also File Formats.** The basic TDCI file format is a compatible extension of NETPBM PGM (PORTABLE GRAY MAP) and PPM (PORTABLE PIXEL MAP) using a simple textual file header and allowing existing image editors to view a TDCI image preview. A TIFF-based advanced format is also planned to encode streams of raw sensor data.

**What Cameras Does TIK Work With?** TIK uses `ffmpeg` and `IMAGEMAGICK convert` to help decode files, so any image or video file format understood by either of those tools can be used as input. Cameras capable of high-framerate video capture, like the SONY RX100 V, are particularly appropriate. However, we also have used CHDK (CANON HACK DEVELOPMENT KIT) to reprogram CANON POWERSHOTS for this; our 3D-printed **FOURSEE** array camera uses four POWERSHOT N cameras to capture the same scene from a single point of view using temporally-skewed still exposures and video, and we have reprogrammed various single CANON POWERSHOTS (e.g., A4000 and ELPH 115IS) to directly capture TIK TDCI files in-camera.

**Want To Know More?** Development of TIK was supported in part by NSF Award #1422811, *CSR: Small: Computational Support for Time Domain Continuous Imaging*. TIK is described in a paper accepted to appear at Electronic Imaging 2017, which is also when we plan to release the software. The TIK software is documented at, and will be distributed from, <http://aggregate.org/DIT/TIK>

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