Rolling Shutter

Or, how to make new cameras look like old ones!
Camera Sensors

- Two Types
  - CCD Charged Coupled Device
  - CMOS Complementary Metal Oxide Semi-Conductor

- They Acquire Images Differently
  - CCD collects an entire frame at once
    - Reads out image one line at a time
    - Global Shutter
  - CMOS collects and reads out one line at a time
    - Bottom of the image taken later than the top
    - Rolling Shutter
Camera Sensors

CCD Sensor

Global Shutter!!
Camera Sensors

CMOS Sensor

Rolling Shutter !!
Okay, so what?

- With fast motion, an object in the image may show up on multiple rows of pixels where it doesn’t belong
  - Rolling Shutter Effect
  - Jello Effect with fast motion and camera shake
- Here’s a short video tutorial on what can happen and why it happens
Rolling shutter effect
So, what makes a CMOS like an old camera?

- Film Cameras have a rotating shutter that effectively scans the image from top to bottom.
So, what makes a CMOS like an old camera?

- Tube TV Cameras scanned the image from top to bottom, one scan line at a time
And Why Do I care?

- Every maker of broadcast cameras has a top-end camera with CMOS sensors
  - They are seen every day, all day long on all types of programming
- How often have you noticed a problem?
- The effect of rolling shutter is virtually invisible with typical video camera shutter speeds, regardless of how fast the subject is moving
  - Typically, video cameras shoot 1/60 shutter and use ND to keep the aperture in a good range
But, when the camera is shuttered, you can see the effect.

- So, we tested some cameras!
- Used a Chopper to get a controlled object in motion
- Shot comparable 1/3” CCD and CMOS cameras at different object speeds and shutter speeds
The Chopper
Comparison

CCD - 1/60 shutter 500 RPM

CMOS - 1/60 shutter 500 RPM
Comparison

CCD - 1/120 shutter 500 RPM

CMOS - 1/120 shutter 500 RPM
Comparison

CCD - 1/250 shutter 500 RPM

CMOS - 1/250 shutter 500 RPM
Comparison

CCD 1/500 shutter 500 RPM

CMOS 1/500 shutter 500 RPM
Comparison

CCD - 1/1000 shutter 500 RPM

CCD - 1/1000 shutter 500 RPM
Comparison

CCD - 1/2000 shutter 500 RPM

CMOS - 1/2000 shutter 500 RPM
More Cameras

Pocket Cinema Camera
CMOS - 1/240 shutter 500 RPM

iPhone 4S
CMOS - ??? Shutter 500 RPM
More Cameras

Red Epic
CMOS, 1/4000 shutter 100 RPM

Red Epic
CMOS, 1/4000 shutter 500 RPM
More Cameras

GoPro
CMOS, ?? shutter 3000 RPM

Lumix GH1
CMOS, ?? shutter 3000 RPM
Now!!!
Let’s Look
At Video
What’s the Future?

- New CMOS Cameras with Global Shutters
- CMOS has been gaining favor because they are less expensive to make & consume less power
  - Inherently more noise than a CCD, but camera CPU power has increased such that processing to remove noise makes CMOS more desirable from a cost standpoint
- Global Shutter CMOS loses some of the cost & power advantages over CCD, but is a preferable solution
Questions ?