Advanced Camera Control Use Cases

- High-dynamic range (HDR) and computational flash photography
  - High-speed burst with individual frame control over exposure and flash
- Rolling shutter elimination
  - High-precision intra-frame synchronization between camera and motion sensor
- HDR Panorama, photo-spheres
  - Continuous frame capture with constant exposure and white balance
- Subject isolation and depth detection
  - High-speed burst with individual frame control over focus
- Time-of-flight or structured light depth camera processing
  - Aligned stacking of data from multiple sensors
- Augmented Reality
  - 60Hz, low-latency capture with motion sensor synchronization
  - Multiple Region of Interest (ROI) capture
  - Multiple sensors for scene scaling
  - Detailed feedback on camera operation per frame
Camera Control API Complements Acceleration

Need Camera API to feed processing pipeline for advanced use cases

Application

Image/Vision Acceleration APIs

OpenGL
OpenCL
OpenVX

Pre-ISP Processing (Bayer Space) → ISP → Post-ISP Processing (YUV Space)

Lens
Sensor
Flash
Precursor APIs for Camera Control Initiative

- **FCAM - Open source project**
  - Capture of stream of camera images with precision control
  - A pipeline that converts requests into image stream
  - All parameters packed into the requests - no global state
  - Programmer has full control over sensor settings for each frame in stream
  - Control over focus and flash
  - No hidden daemon running
  - Control ISP
  - Can access supplemental statistics from ISP if available

- **Android New Camera HAL (2013)**
  - Uses some of these concepts
Potential Camera Control API Functionality

- **Burst Sensor Control**
  - Exposure, time, gain, CFA pattern ...

- **Burst Lens control**
  - Target focus distance, aperture, focal length, position state ...

- **Burst Flash Control**
  - Brightness, duration, burst, activity state ...

- **ISP Control**
  - Demosaicing quality, denoising quality, 3A, CCM, Gamma, color space ...

- **Output(s) Control**
  - Resolution, ROI extraction, quality, format (including Bayer, YUV) ...

- **Frame timestamp**
  - To be used to synch with motion sensors

- **Parameter access**
  - Standard-defined parameters AND Vendor-specific extensions registry

- **Feedback Statistics**
  - Histogram, sharpness map ...

- **Multi-sensor control**
  - Synchronization, master sensor controlling other sensors, image stacking

- **Metadata**
  - Per frame: Focal length (fx, fy), principal point (cx, cy), skew (s), image resolution (h, w), exposure
  - Per device: Cameras and sensors physical layout, calibration and lens distortion
Camera Control API Usage

Burst control of sensor, flash, lens with precision timestamps on frames

Precision timestamps on positional sensor samples

Application