

Camera Phone Image Quality (CPIQ) Performance and Quality Metrics

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Motivation

- Lack of existing standards for measuring, reporting and comparing camera-phone image quality
- “Identical” devices (in terms of Megapixels) produce significantly different performance, creating dissatisfaction and confusion among customers
- Testing methods and procedures not controlled or well-defined for measuring manufacturing processes and confirming specifications
- Provide consumers with an overall image quality rating method that could be used for comparisons

Let's get started...

- A group of companies from all aspects of the mobile imaging marketplace came together under I3A to form the ***CPIQ Initiative group***

Advanced Micro Devices (AMD)	NVIDIA
Aptina Imaging (formerly Micron)	OmniVision Technologies, Inc.
CDM Optics, Inc.	Palm Inc.
DxO Labs	Philips Lumileds Lighting Company
Eastman Kodak Company	Sensata Technologies
Foveon, Inc.	Sony Ericsson Mobile Communications
Freescale Semiconductor Inc.	Sprint
FUJIFILM Corporation	STMicroelectronics
Hewlett Packard	Texas Instruments Inc.
Image Engineering	Tessera (formerly FotoNation)
Motorola, Inc.	Verizon Wireless
Nethra Imaging	Vista Point Technologies
Nokia Corporation	Zoran Corporation

Phase 1: Survey and Approach

- Expectation: Metrics and methods to be grounded in image quality measurements used for years to characterize photographic and digital imaging systems
 - Categories: sharpness, color fidelity, tone reproduction and exposure, noise and artifacts, geometric accuracy
- Survey existing standards, utilize where appropriate, modify as needed; outline planned approach in Phase 1
- Key value-added extension: Recommend to use subjective evaluations to provide a framework in which to understand the magnitude of the objective performance measurements

Scope of work

- Phase 1: Described attributes that principally contribute to camera phone image quality and identify existing standards
- Also identified two important considerations when assessing image requirements:
 - “**Use case**” for images has significant impact on subjective performance assessments: phone-to-phone, web, HDTV, widescreen computer monitor, hardcopy prints
 - The distribution of common picture types (“**photospace**”) should be considered when evaluating tradeoffs

Scope of work

- Phase 2: Defines the objective methodology and subjective performance correlations for key IQ drivers
 - Measurement tools and procedures
 - Sample analysis code and example results
- Established an analysis framework and template for providing results from all future metrics
 - Objective measurement approaches suggested and reviewed
 - Sample images with varying levels of artifacts created or acquired
 - Subjective evaluation of performance conducted using standardized approach and common scale (just noticeable differences, JND's)
 - Results from objective metric analysis published relative to observer subjective quality assessment

Example summary result

Objective Metric:

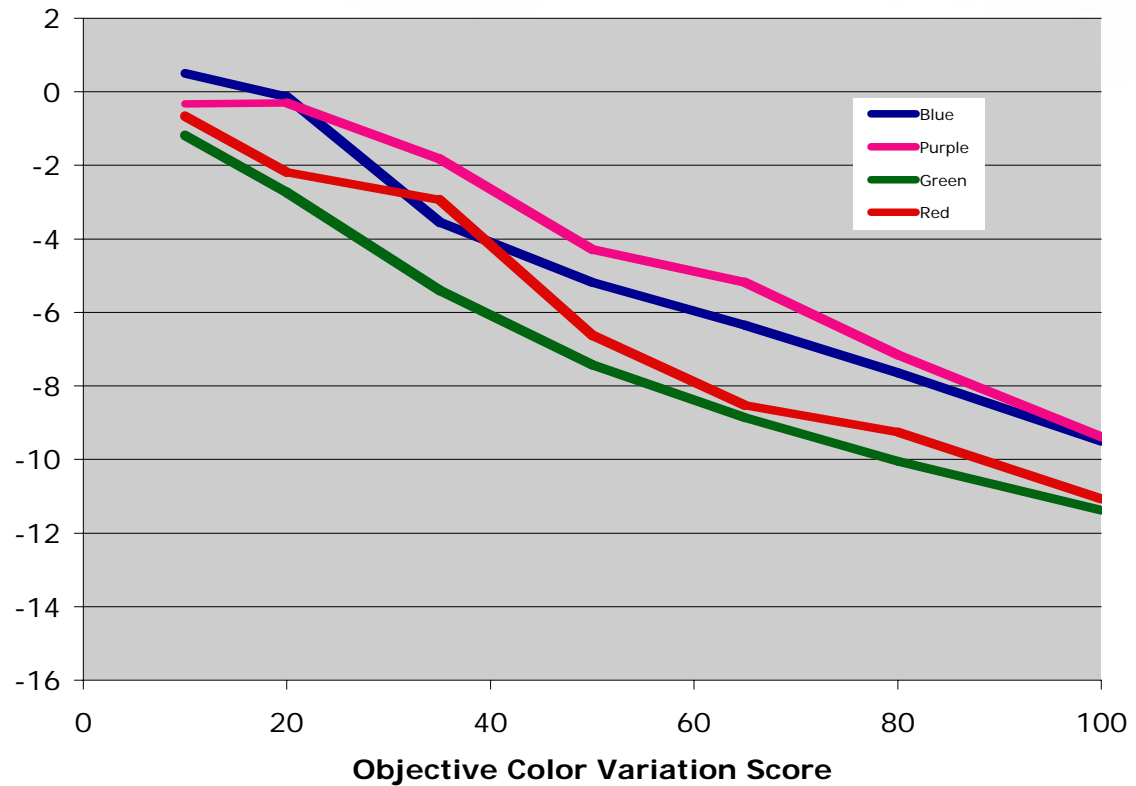
$$d_i = \sqrt{(a_i - a_o)^2 + (b_i - b_o)^2}$$

$$d = \max(d_i)$$



Example Image

Color Variation JND Performance (Average over all images)



Objective and Subjective Teams

- Metric development and image quality assessment occur in parallel
 - The objective team evaluates candidate objective measurement approaches
 - The subjective team independently evaluates consumer-based subjective quality degradations introduced by the parameter under investigation
 - Results are jointly reviewed for correlation and the most appropriate objective algorithm documented
- This approach provides consistency between all metrics, and efficient collaboration between objective and subjective components

What has CPIQ accomplished so far?

- Objective Test Methodology
- Subjective Evaluation Procedures
- Acutance: Spatial Frequency Response (SFR)
- Color Uniformity
- Lens Chromatic Aberration
- Lens Geometric Distortion

Texture and Detail - Report on a work in progress

Where do we go from here?

- Phase 3 will build on the work from Phase 2 by adding additional IQ metrics, evaluated using our objective/subjective methodology
 - Results compiled in a chapter-based document, with additional metrics added as new chapters
- Final step: Establish an overall image quality rating system that can utilize the subjective JND levels to generate a single, consumer-focused quality score for device comparisons (possibly based on use-case)

Here and Now: CPIQ Methods and Findings

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