I4DC

Technical Specifications

Principle of operation

I4DC is a robotic camera mount for creating high-resolution panoramic or full spherical HDR images (HDR = high dynamic range). It uses a digital SLR camera and lenses with wide viewing angles. The full spherical image (360°×180°) is assembled from a number of individual images using specialized processing software running on a computer.

The device has a built-in microcomputer that enables advanced functionality. It can be operated via the built-in push button or by remote control. For full spherical image capture, the camera is positioned automatically to several overlapping viewing directions. In each position a sequence of images with different exposure and ISO settings is taken. The capture process can be paused or canceled. Capture parameters can be adjusted to optimally fit the scene to be photographed, or the user can choose to use automatic operation.

Images are saved on a memory card (CompactFlash or SD/SDHC/SDXC, inserted into the DSLR camera). Individual images are marked with special meta tags, so they can be sorted and aligned automatically by the I4DC Stitcher software.

After copying the images from the memory card to the computer, the final panoramic image is generated by the processing software and stored on the computer's hard disk. This process is called "stitching" and includes sophisticated algorithms for HDR image generation, alignment, blending and tone mapping.

General technical data

Device:
Servo-motor driven two-axis DSLR camera mount with built-in microcomputer and wireless networking
Camera:
Can use Canon EOS 5Ds, 5Ds R, 5D Mark II, 5D Mark III, 5D Mark IV or 6D
Lens:
Choice of 15mm Fisheye or 18mm Zeiss lenses (lenses come precision-aligned for optimal stitching results, virtually parallax-free)
Image resolution:
100 to 500 Megapixel, depending on lens/camera combination (final image size after stitching)
Dynamic range:
From 12 up to 30 f-stops (HDR)
Image capture duration:
15 seconds to 7½ minutes

Settings

HDR modes:

- **Auto/Max** (complete bracketing depending on base exposure setting, i.e. 18 to 30 f-stops)
- **5 Shot** (bracketing of 5 shots at ±3 and ±6 f-stops offset from base exposure setting, i.e. 24 f-stops)
- **3 Shot** (bracketing of 3 shots at ±3 f-stops offset from base exposure, i.e. 18 f-stops)
- **1 Shot** (no bracketing, i.e. approximately 12 f-stops)

Base exposure:
Automatic or manual from 30 seconds down to 1/8000 seconds (1/4000 seconds with EOS 6D). Device will bracket from chosen base exposure time down towards shorter exposure times.
ISO:
Automatic or manual; 100 up to 6400.
Aperture:
Automatic or manual; f2.8 to f22.

Remote control

Wireless remote control device: Apple iPod touch or similar WiFi-enabled mobile device. Android phones or tablets are supported. Any device with a compatible browser works.

- Wireless network: Wi-Fi IEEE 802.11g (54 MBit/s) using external WiFi-USB stick
- Encryption: WPA and WPA2 with TKIP or AES encryption (pre-shared key)
- Unencrypted or WEP-encrypted connection attempts are denied
- Wi-Fi can be physically disabled by removing the WiFi stick or with a on/off switch

The web user interface can also be accessed with a notebook or PC connected by Ethernet cable.

Image capture speed

Depends on scenery (daylight, indoors, night), capture settings and lens/camera combination in use. The following times are for the 100/200 Megapixel version:

- **About one minute typical** capture time for a reasonably lit indoor scene ("Auto/Max" mode at 1 second base exposure)
- **15 seconds shortest** capture time for an outdoor scene and full daylight ("3 Shot" HDR mode at 1/15th second base exposure)
- **about 7½ minutes longest** capture time for a night scene with minimal lighting ("Auto/Max" HDR mode at 30 seconds base exposure)

Capture times will double when shooting 500 Megapixel using the Zeiss 18mm lens.

Scenes taken in "3 Shot" HDR mode will capture faster. Well lit scenes will generally allow faster capturing. Capturing in darkness with only minimal lighting is possible.

The boot-up time from pressing the power button to being ready to capture is about 20 seconds.

Image processing speed

Depends on scenery, capture settings and computing power. The processing of camera RAW files into the final panoramic image is a matter of a few minutes. Scenes with lower contrast will generally render faster. Scenes taken in "3 Shot" HDR mode will generally render faster.

Processing will typically take around 1 minute on current high-performance notebook hardware.

Automation and "fail-safe" features

- **Auto exposure** for automatic selection of capture parameters
- **Accurate inclination sensor** for automatic leveling of images
- **GPS** for automatic geotagging of images (requires a GPS-enabled Canon camera, i.e. the EOS 6D or the 5D Mark IV).
- **Friction brakes on both axes** for eliminating wind-induced movement

Battery and power

Replaceable Lithium Ion battery with charge status indicator.

Idle endurance:
approx. 8 hours at 20°C (battery life when device is powered on but not capturing)
Busy endurance:
approx. 200 panoramic images at 20°C (battery life when device is capturing continuously)
Line voltage:
AC adapter for 100 to 240V AC, 50 to 60 Hz. Battery can be charged while inserted in device. Device may be operated without battery.

The I4DC device will also supply power to the Canon EOS camera. Canon batteries and charger are not required.

External connectors

- 1x DC in (for AC adapter to power the internal battery charger)
- 2x USB 2.0 (for recharging the iPod or attaching a USB memory stick)
- 1x Gigabit Ethernet (RJ-45 connector)
- Cables for Canon camera connection (USB and power)

Environmental

- Temperature (operating): 0°C to 40°C (-10°C tested ok, but not guaranteed)
- Temperature (internal battery charging): 0°C to 40°C
- Temperature (storage): -20°C to 60°C (20°C recommended)
- Humidity: <80% RH non-condensing, no frost
- Water: Device is not waterproof.
- Wind: <4 Bft or <20 km/h when used with standard tripod. Use heavy tripod or special mount when operating in stronger wind.

Size and weight

Size:

- Width: 200 mm (7.9 in)
- Depth: 160 mm (6.3 in)
- Height: varies with camera position, maximum is 250 mm (9.8 in)

Weight:

- Device: 3.7 kg (8.2 lbs) (including 5D Mark III camera, lens and battery; without tripod)
- Battery: 340 g (0.75 lbs)

Wheeled trolley case:

- Size: 545x350x230 mm (21.5x13.8x9.1 in)
- Weight (empty): 5.5 kg (12.2 lbs)

Chassis

Chassis material is aluminum (anodized), some parts stainless steel and plastics. Color black.

Device has a centered standard 3/8"-16 thread for attaching a tripod adapter. A Manfrotto MA323 adaptor is included.

Scope of delivery

We supply complete systems (including Canon camera, tripod, etc.) as well as "barebone" configurations. Please see the price list (/pricing/) for details.

The device can be used with existing Canon EOS cameras (see list of supported models). The precision-mounted lens is always included in the "barebone" configuration.

Supported Camera models

I4DC supports the Canon EOS 6D, 5Ds, 5Ds R, 5D Mark II, 5D Mark III, 5D Mark IV. Other camera models or manufacturers are not supported.

The camera can easily be unmounted from the I4DC device and used independently, also with other lenses.

Processing software system requirements

Operating systems:
- Windows 10 (64 bit)
- macOS 11.0 (Big Sur), macOS 10.15 (Catalina), 10.14 (Mojave)
- Parallels Desktop for Mac is not supported (it may work, no guarantees)

Hardware:
- Intel compatible CPU (Intel Core2 or later, AMD Athlon/Opteron or later)
- Note: Mac computers with Apple Silicon (M1 chip) are currently not supported
- min. 8 GB of RAM
- min. 500 GB of free hard disk space
- Graphics chip (GPU/graphics card) with OpenGL 3.3 support
- Graphics chip with at least 2 GB of dedicated graphics memory (4 GB for processing 500 megapixel sphericals)

The processing software depends on the graphics processing unit (GPU) for basic operation and speed. It will not run on computers without graphics card or with an aging GPU. Graphics drivers must be current, outdated drivers will probably cause issues. Computers with multiple CPU cores are recommended. A recent GeForce or Radeon GPU is strongly recommended.

File formats and size

The I4DC system shoots "camera raw" images to obtain maximum image quality. The space consumed by the set of raw images per panorama depends on the selected HDR mode, the dynamic range of the scene and the lens/camera combination in use. Space requirements vary between 150 MB and 4 GB per spherical image. Typical raw file sizes for one 100 Megapixel panorama are
- Auto/Max HDR mode: 1 GB
- 3 Shot HDR mode: 450 MB
- 1 Shot HDR mode: 150 MB

After stitching, the panoramic HDR image will be saved in equirectangular geometry in the RADIANCE (*.hdr) file format with a dimension of 14140 × 7070 pixels (100 Megapixel) up to 31800 × 15900 pixels (500 Megapixel). The size of such a file will typically be about 290 MB (100 Megapixel) up to 1.4 GB (500 Megapixel). Image size varies with image content.

Additionally, a tone mapped JPEG image is produced at full resolution and at a thumbnail resolution of 1000 x 500 pixels. There is also support for generating JPEG and OpenEXR cube face files with image sizes of up to 4096x4096 pixels per face.