

# Design of Digital Cameras which Pursues Essence of "Camera"

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## Overview

Reviewing a digital camera from the viewpoint of the "tool of taking picture", Canon developed a new camera "PowerShotA5" which has comparable operability and portability to a conventional camera. And it also achieved in the quality of picture, that can be rivaled to conventional film photo at post card size print.

## Introduction

The ease with which digital cameras may be used together in conjunction with PCs and communications networks and the greater range of freedom they provide in terms of image size and the taking of pictures when compared to camcorders or conventional film cameras have made these devices one of the central tools driving the multimedia revolution and have contributed to a rapid rise in demand for digital cameras.

Yet the VGA digital cameras which served as the driving force behind the increasing popularity of these devices have limitations in that the largest true photo-quality print size is only about the size of an ordinary business card, thus making them poorly suited for regular use as a full-function camera. Moreover, those high-resolution digital cameras which do provide high-quality pictures have their own problems in that many of them are too large or take too long to record image data, thus making these higher-grade camera difficult to use.

In point of fact, there is no digital camera on the market yet which satisfies all of these needs, i.e., there is no digital camera on the market which not only provides all the features needed of a camera as a multimedia tool but which also allows users to enjoy the pleasures of taking pictures.

## Development requirements

Going back to the basics and recognizing that a camera ought to serve as "a tool in photography," we set the following requirements in the design of the new digital camera:

- Sufficient photo quality (i.e., the same picture quality as that obtainable using an ordinary

- film camera when producing postcard-sized prints)
- Highly portable (i.e., that its exterior be completely flat and that it be small enough to fit into a shirt pocket)
- Ease of use (i.e., that it be able to be used in the same way as an ordinary film camera and that users be able to take successive pictures at sufficiently short intervals)
- Compatibility (i.e., that it be able to be connected to other multimedia devices and that it be compatible with a wide range of PCs and other cameras)

## Development of the PowerShot A5

### - Photo quality

When one considers the picture quality provided by ordinary silver halide film, one sees that in order to provide the same level of photo quality in postcard-sized prints (96.6 x 136.9 mm) of pictures taken with a digital camera, it is necessary to provide a resolution of 3.5 line pairs per millimeter or a total of 810 thousand pixels in terms of the total number of CCD pixels. Furthermore, when one considers the relation which exists between the size of the body of the camera and restrictions in terms of the pixel size needed to ensure sufficient sensitivity of the sensor, one sees that One-third inch image sensor should be adopted to the camera.

In order to make the sensor perform at its best it becomes necessary to use a lens with a resolution greater than the resolution calculated from the pixel pitch, and when designing a digital camera steps must be taken to ensure that this level of resolution is maintained even in the periphery of pictures.

To pack this level of performance in a compact optical system, we developed a front-focusing system consisting of a total of five lenses with two aspherical lenses (Fig.2).



Fig. 1 PowerShot A5

The use of aspherical lenses provides excellent correction capabilities against distortion. And what is more, the use of a telecentric optical system reduces the amount of crosstalk occurring between neighboring pixels and provides protection against the blurring of colors, thus making the lens one which is both compact and capable of providing excellent picture quality.

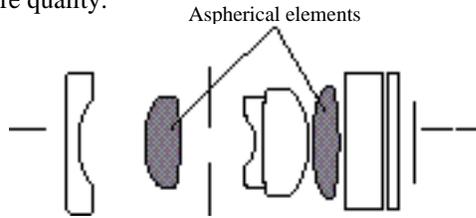


Fig. 2 Lens cross-section

**- Portability**

In order to make the PowerShot A5 more compact and portable, we developed a new retractable-lens design in which the front lens unit may be retracted into the body of the camera when not in use and extended to the required position only when actually taking pictures (Fig. 3).

The use of this retractable lens in turn made it necessary in turn to develop a new (Fig. 4) ultra-compact motor just 3 millimeters across in diameter for use in opening and closing the lens cover in the new camera.

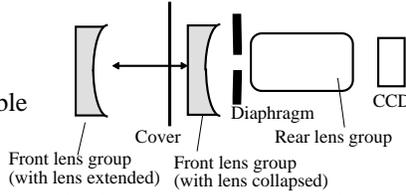


Fig. 3 Lens retracting mechanism

We also developed a new compact stepping motor for use as an actuator to drive the lens unit and built the motor into the lens barrel (Fig. 5), where it is used both in focusing and in retracting and extending the lens. This design made it possible to reduce the amount of space required around the lens barrel.

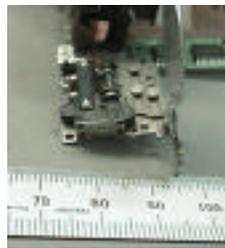


Fig. 4 Ultra-compact motor

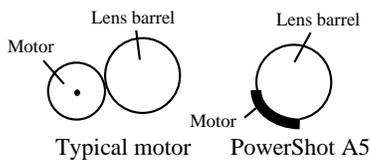
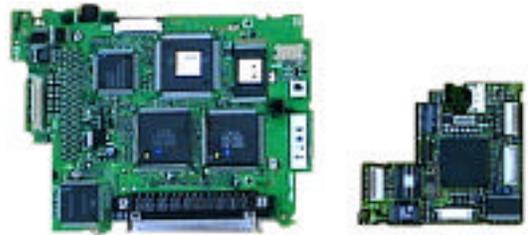


Fig. 5 Built-in motor

A chip size package (CSP) chip was also used to greatly reduce the area taken up by the circuit board within the camera, and an eight-layer mainboard and four-layer rigid/flexible circuitboard were used to make it possible to optimize the internal layout of the camera.



PowerShot 600's Mainboard PowerShot A5's Mainboard

Fig. 6 Comparison of mainboard

These efforts have paid off in making it possible to develop a camera with a fully flat body that fits easily into a shirt pocket just 103 millimeters in width, 68 millimeters in height, and 32.5 millimeters from front to back-the smallest XGA camera of its kind.

**- Ease of operation**

In order to ensure ease of operation and use, in developing the PowerShot A5 we placed a heavy stress on giving it a look and feel as close as possible to that of conventional compact cameras.

First, we decided to place the lens in the center of the camera so as to help prevent the problem of users inadvertently placing their fingers over the lens when taking pictures. And by using a mode-dial control together with a combination of graphical symbols, we made it possible for users to visually verify the operations being performed as they are performed.

To prevent problems in terms of lost photo opportunities, it is also important to reduce the length of the minimum interval between pictures, and for this reason instead of the software-processing design commonly found in other cameras, in the PowerShot A5 we decided to use a hardware-processing design to increase processing speed. This made it possible not only to provide better picture quality but also to display messages on the LCD display in real time and to increase the speed at which image data can be recorded and reproduced, and it also reduced the interval of the delay between pictures by 4 seconds and made it possible for the PowerShot A5 to be used to take pictures at a rate of one shot per second.

**- Compatibility**

To make it possible to connect the PowerShot A5 to other multimedia devices, it was fitted with a video output port and serial interface, and in selecting the storage media to be used we decided to use compact flash (CF) memory cards (Fig. 7). The memory cards which not only provide plenty of storage capacity but which also provide high reliability and compatibility with PCs at the level of the logical interface.



Fig. 7 CF Memory card

We also designed a new camera image file format (CIFF) which ensures excellent compatibility between PCs and other cameras and adopted this format for use in the PowerShot A5. CIFF not only uses standard JPEG/JFIF data files, but it also has a directory and file naming structure which greatly reduces the load placed on the camera driver software when creating or searching for files (Fig. 8).

#### DigitalCamera

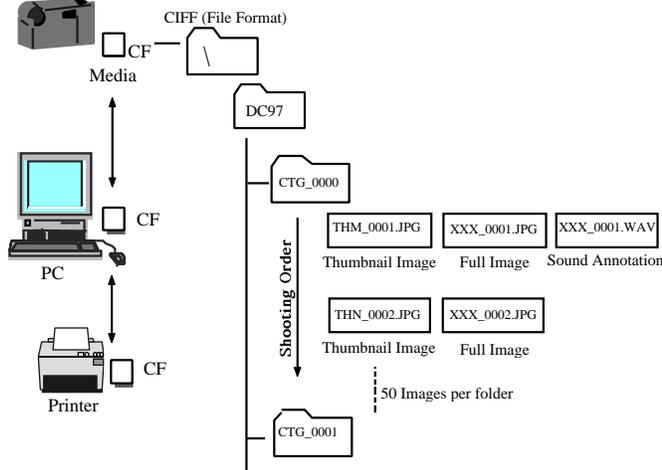


Fig.8 CIFF's file/folder structure

For applications software, we also bundled our Stitch image composition software with the PowerShot A5. This not only makes it possible to create panorama photographs from separate images, but it also makes it possible to perform two-way composition and thereby create larger photo-quality prints than ordinary XGA-size prints. The use of the CIFF file format also makes it possible to easily access PowerShot A5 images from most common Windows applications, thus making it possible for users to edit images using whatever image processing tools they are most familiar and comfortable with.

## Conclusion

We believe that the design of the PowerShot A5 is such that it is capable of fulfilling the needs of a wide variety of different types of users. And to make it possible to produce cabinet-size photo-quality prints too, this summer Canon will be releasing the PowerShot Pro 70, a 168-thousand CCD pixel camera which will make it possible for digital cameras to be used by professional photographers and in other fields where there is a need for larger-size prints.