History of World's First Commercialization of Image Stabilizers for Handheld Cameras

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***Abstract*— For more than a decade, *Image Stabilization* (IS) technology has been considered essential to delivering improved image quality in professional cameras. More recently, as a result of advancing technology, IS has become increasingly popular to handheld device makers who want to propose high-end features for their products. Hence, manufacturers like Panasonic have worked hard on its technologies and methods for IS to significantly improve camera shutter speed and to offer precise suppression of camera vibration. This article overviews the history of world's first commercialization of image stabilizers for handheld cameras.**

Keywords—camera vibration, handheld camera, image quality, image stabilizer

I. INTRODUCTION

The camera was commercialized first by Eastman in 1889, which was so difficult to operate that it was used restrictedly by professional photographers, not by general consumers. For more widespread use, the following three technologies were indispensable; the automatic exposure technology invented by J. Durst (Agfa) in 1956, the autofocus technology invented by N. Stauffer (Honeywell) in 1973, and the IS technology invented by M. Oshima (Panasonic) in 1983 and commercialized by Panasonic in 1988 [1].

Today, from the technological point of view, *Digital Image Stabilization* (DIS), *Electronics Image Stabilization* (EIS), and *Optical Image Stabilization* (OIS) are the best understood and the easiest to integrate in *Digital Still Cameras* (DSCs) and smartphones, although they can produce different image quality results. In fact, DIS and EIS electronically correct the captured image, resulting in image quality degradation as well as in augmentation of memory and computational resources on the hosting devices. On the other hand, OIS not only optically corrects the captured image without any quality degradation, but also minimizes memory and computational demands on from the host [2].

Since OIS acts directly on the lens position itself, and as an electromechanical method, lens stabilization is the most effective for removing blurring effects from involuntary hand motion or shaking of the camera [2], Panasonic has regarded OIS as the most practical for avoiding camera blur and immediately begun to develop an OIS system, or image stabilizer, integrated into a handheld camera (see Fig. 1).

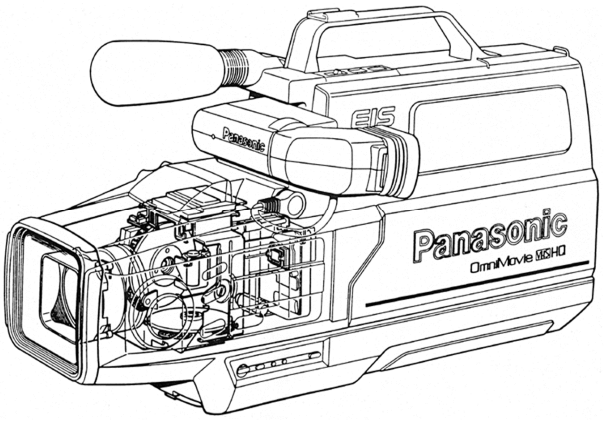

Fig. 1. Handheld camera with image stabilizer

In this article, the history of world's first commercialization of image stabilizers is overviewed, where it should be noted that unless otherwise specified, OIS is denoted simply by IS.

II. IS TECNOLGY SINCE 1980

(1) IS technology around 1980

If there were IS systems for military and cinematographic use, none could be integrated into handheld cameras, since they were several times larger and heavier than cameras. If the IS for use on aircraft necessitated sensors and correction mechanisms, none had been attempted for handheld cameras. Furthermore, at that time IS was not necessary for consumer-use cameras, so no attempt was made to develop it, and there was neither any ultra-compact gyro-sensor nor optical component that could be mounted on a handheld camera.

(2) Impact of IS technology on today's world

(a) Impact to technology

Panasonic's invention covers not only IS [3] but also EIS [4] and *Body Image Stabilization* (BIS) [5],[6] mounted on interchangeable lens cameras. The IS technology is used for image stabilizers in cameras currently in use. Furthermore, this technology is used for almost all modern handheld cameras, such as interchangeable lens, compact digital, and digital video cameras for broadcasting or smartphones, and is also widely used by people all over the world.

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(b) Impact to market

Panasonic was the first to incorporate IS into camcorders in 1988, making a huge impact on the market. Panasonic was also the first to integrate IS into compact DSC in 2003. The DSC of brand name 'DMC-FX7' (see Fig. 2) manufactured in 2004 acquired a worldwide hit.

According as cameras became smaller and lighter, and the effects of camera blur increased due to more one-handed shooting, IS made it possible to capture more and more clean images. In recent years, the smartphone market, like the DSC market, has been moving in the direction of adopting smaller, lighter, and higher resolution cameras. At the same time, however, blurring caused by involuntary movements has a significant impact on image quality, and moreover, the lighter the smartphone, the greater the blurring. To address this issue, IS invented by Panasonic was first introduced in the iPhone 6S smartphone in 2014 [7], and has since been incorporated in many smartphones.

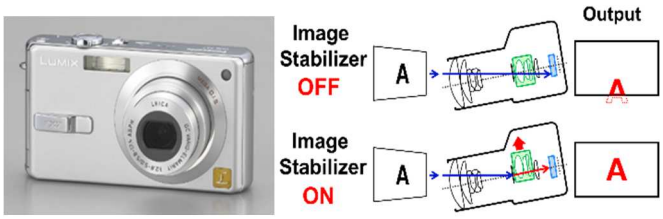

Fig. 2. Compact DSC 'DMC-FX7' and principle of IS

III. Dvelopmet Of IS By Panasonic

In 1980, rotary gyro-sensors, the key devices for IS, were available, but too large and heavy to be mounted on a camera. We therefore turned our attention to the vibration gyro-sensor invented by R. Barnaby (Sperry) in 1948 [8], which could be made smaller, but unstable at that time. The noise generated by external shocks, in particular, would cause blurring of the image when used for IS, so we identified the cause of the noise and incorporated the tuning-fork structure with monitor and driving elements. Signals from the monitor element were used to feedback control of the driving element, thereby greatly reducing noise and eliminating screen shake caused by the vibration gyro-sensor. Thus, we introduced a new compact, light-weight, and inexpensive tuning-fork vibration gyro-sensor, as shown in Fig. 3.

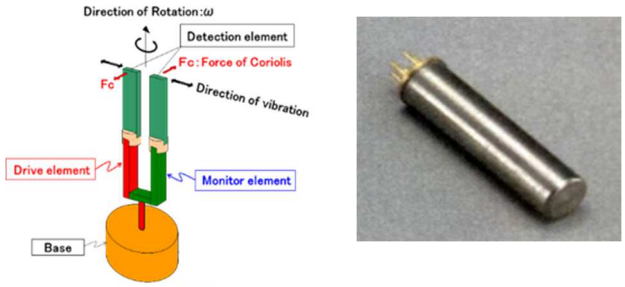

Fig.3. Tuning-fork vibration gyro-sensor

Every Panasonic camera has an IS, which is intended to compensate for handshake and camera movement in all four directions, up, down, left, and right. A gyro-sensor detects tiny movements of the camera and moves the IS lens in the opposite direction to steer the image onto the image sensor. This reduces blurred images that would normally occur as a result of camera movement. In addition, the IS is particularly effective when taking pictures where you are zoomed in, at a distance from the subject. Using a high magnification exaggerates the effect of camera movement, causing increased image blurring. IS compensates for this movement, producing a clear picture [9].

Panasonic was the first to introduce shooting mode identification function into cameras with IS. When the photographer tries to change the shooting direction during IS, the camera judges the change in shooting direction as camera shake and compensates for it, resulting in the shooting direction not changing as the photographer intended. In response to this issue, the camera can shoot as the photographer intended by optimally controlling the image stabilization method based on the photographer's shooting intention (e.g., panning) [1]. This mode discrimination and control technology is still in use today in photographic equipment.

In recent years, photography enthusiasts have made extensive use of interchangeable lens cameras in their quest for higher quality images. Panasonic has developed DUAL-IS system, as shown in Fig. 4 [6], which coordinates the IS built into the interchangeable lens and the BIS built into the camera body, to improve IS performance.

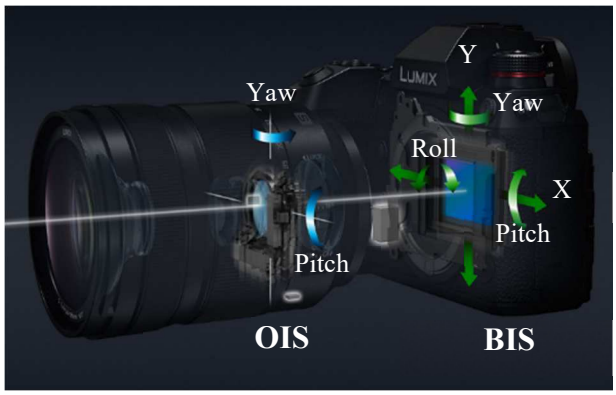

Fig. 4. Interchangeable lens camera with DUAL-IS system

IV. Obstacles To Be Overcome

The DSC market has moved towards smaller sizes, lower weight, and higher resolutions, and mobile camera modules have followed the same trend after their introduction in smartphones and handsets. A big drawback to this development has been the impact of blurring, caused by involuntary motions, on image quality. In fact, lighter cameras produce greater blurring [2].

The introduction of IS in several mobile platforms has been a significant added value for photography lovers, especially for younger users, who replaced traditional and bulky cameras with brand-new smartphones, or had cameras available to record memories, simply because those cameras were embedded in the mobile platform they were already carrying. Smartphones are lighter and are often taken with one hand, and hence they are easily blurred, making the value

of installing IS even greater. IS in smartphones enables pictures and video with quality comparable to DSCs in so many operating conditions. As a consequence, the request for IS is increasing both in compact DSCs and smartphones [2].

V. Distinctive Features Of IS

A number of distinctive features associated with IS are outlined in what follows:

(1) Picture blurring caused by camera shake, a biological phenomenon occurring at a frequency below 20Hz, is even more evident in higher resolution cameras. In fact, in smaller resolution cameras the blurring may not exceed one pixel, which is negligible; but in higher resolution ones it may impact many pixels, thus degrading image quality significantly.

(2) Shooting indoors or in darkness requires a wide lens aperture because of sufficient amount of light requirement. However, if camera shake is large, the image is blurred with degraded quality. To reduce the effects of camera shake, a faster shutter speed reduces camera shake, but there is also the problem that a faster shutter speed reduces the amount of light. Anyhow, IS minimizes the effects of camera shake, so good images can be taken even in dark environments without increasing shutter speed.

(3) Panasonic has developed a *Dual Image Stabilizer* that cooperatively controls two IS methods, optical IS and image sensor driven IS for interchangeable lens cameras that require high descriptive performance, and has achieved image stabilization performance that far exceeds that of conventional IS. This allows it to be used in a wide range of situations including sports, animals, portraits and vehicles.

VI. Conclusion

Since the commercialization of IS by Panasonic in 1988, a variety of producing methods have been developed as essential features of cameras. As a result, it has been incorporated into a wide range of products, from professional cameras to smartphones, providing high quality images to a wide range of users. More recently, thanks to mobile technology evolution, it has rapidly become an essential feature across flagship smartphones.

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