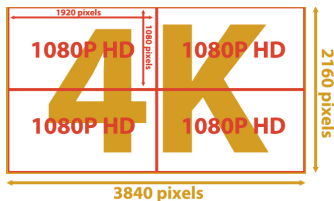


## The Panasonic AG-UX90: A Low Cost Camera For Professional Applications

The Panasonic AG-UX90 represents the lowest-cost Ultra High Definition camcorder currently in Panasonic's 2016 lineup of professional camcorders, as of December 2016. Replacing its predecessor (the high-definition-only AG-AC90), the UX90 provides substantial upgrades in imaging capability, camcorder flexibility, and professional usability, and debuts at a price point that's even lower than HD-only predecessor was introduced at.

In this paper I will examine some of the technological advancements in the AG-UX90 that make it such a considerable advancement over prior low-cost cameras, especially as it pertains to the camera operator's perspective.

### Ultra HD Recording



The AG-UX90 is an Ultra High Definition camcorder, capable of recording video in a frame size 3840 x 2160 pixels (known as UHD or 4K). It supports the standardized television implementation of UHD/4K at 23.98 or 29.97 progressive-scan frames per second. This frame size is literally four times as large (or provides up to four times as many pixels) as a typical Full HD frame. The consumer television industry and

streaming program providers such as Netflix and YouTube currently support 4K.

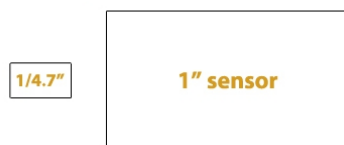
The AG-UX90 uses a large 1"-type sensor and a native 3,840 x 2,160 pixel patch on that sensor to produce full-resolution, high-quality UHD images. The AG-UX90 is also a fully-capable HD camcorder, supporting 1920 x 1080 Full HD at 23.98, 29.97, or 59.94 progressive-scan frames per second, in addition to the television standard of 59.94 interlaced fields per second (1080i).

The leap in image quality for UHD versus FHD is difficult to overstate: the clarity, crispness, and detail are all massive improvements over HD-only camcorders.

### Large Sensor

The AG-UX90 uses a 1" type sensor, which is a comparatively huge sensor for a conventional video camera. This is the first time Panasonic has used such a large sensor in such a low-cost professional camcorder. Historically, lower-cost cameras have utilized smaller sensors (typically 1/3" or 1/4"), and the large sensors have been utilized only in the more expensive models (typically using 2/3" type sensors). The AG-UX90's predecessor used 1/4.7" sensors, which are even smaller than 1/4" sensors; in comparison, the AG-UX90's sensor is relatively gigantic – it's almost 16 times larger than a 1/4.7" sensor! It is approximately twice as large as the 2/3" sensors used in common full-size broadcast camcorders.

#### Comparative Sensor Sizes



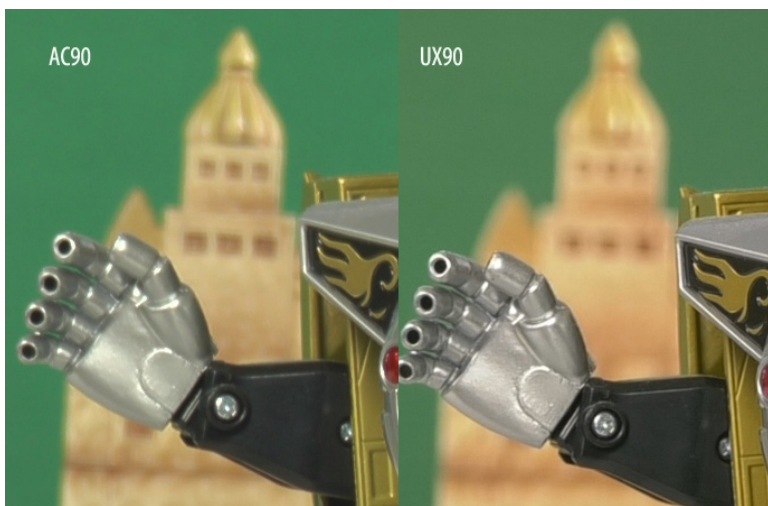
Large sensors offer several benefits over smaller sensors; chief among these benefits are increased sensitivity, increased dynamic range, and shallower depth of field. In practical terms you'll generally see low light sensitivity has increased by 1.5x to 2x over the comparably-priced prior model (depending on the zoom setting and the maximum iris at that setting).

Another benefit of a large sensor is that it may afford more creative control to the user, in terms of the ability to isolate a subject and focus the user's eye through the use of selective focus. Put simply, when all other things are equal, the larger sensor will deliver images that have a shallower depth of field than

a smaller sensor will. The implementation of a large sensor in the AG-UX90 means it is capable of delivering a more shallow depth of field look than a smaller-sensor camera could. With small-sensor cameras, the videographer or cinematographer is frequently dealing with an image where everything is in focus, from the closest subject to the furthest background. But with a large-sensor camera, it may be easier to isolate the subject, blurring the background somewhat and directing the user's eye towards the desired subject.



*In the still frames above, the video on the left was taken with a small-sensor camera; the video on the right was taken with an AG-UX90 from the same position and under the same lighting. Look at the buildings in the background; they're certainly blurrier in the frame from the UX90, and the difference really stands out on a large-screen display.*



The picture on the left is an extraction from the high-definition frames that shows more clearly the difference in the depth of field between these two shots.

Note that these shots were taken with maximum wide-open irises on both cameras. If we had instead showed the difference when the cameras were set to equivalent irises, the differences would be more noticeable, as seen below.



*In the above example, both cameras were set to  $f/4.0$ . The small-sensor camera is on the left; the UX90 is on the right. In both cases, focus was set on the central robot's face. You can see that in the small-sensor camera, pretty much everything is in sharp focus, from the far-right robot's knuckles to the buildings in the background. On the AG-UX90 picture, only the center robot is in sharp focus. The robot on the right is out of focus, and the one on the left is only partially in focus, and the background is totally out of focus. You can see the difference more clearly in the extractions below.*



*This extraction from the above frame more clearly shows the differences in focus. Focus was set on the same point (the central robot's face) as best as possible. The robot is in sharp focus, but the building behind it is completely out of focus on the UX90 shot; on the small-sensor AC90 it's in crystal clear focus. Also, look at the hand and sword of the robot on the right edge of the frame; on the UX90 it's quite blurry, but on the AC90 the focus is only just beginning to go soft on the hand and sword.*

The improved shallow-depth-of-field capability may make the AG-UX90 more usable for more different types of jobs. A small-sensor deep-depth of field camera might be fine for, say, covering sports or outdoor events, but it may not necessarily be the most desirable choice for interviews or product beauty shots. The UX90's capability for reduced depth of field may make it more suitable for more and different types of shots that were previously not practical on a smaller-sensor camcorder.

### **Zoom Range**

The AG-UX90 offers a considerably extended zoom range as compared to its predecessor (and as compared to cameras offered by the competition). A 12x zoom is fairly standard and common in camcorders in this class and price range, but the new AG-UX90 extends that to 15x, and offers the widest wide-angle field of view of any camera in its class – at maximum wide-angle in Full HD mode, the field of view is equivalent to a 24.5mm wide lens on a full-frame photography camera. That's approximately 20% wider than earlier cameras were capable of displaying, and can make a valuable difference in the videographer's ability to “get the shot” when in tight quarters or small rooms.

The AG-UX90's 15x zoom range gives it an equivalent of 24.5 mm to 368 mm in comparison to a full-frame photography camera, when in Full HD mode. That's a highly useful zoom range, suitable for anything from tight-quarters work to nature videography. It is significantly wider and even slightly longer than the zoom range of other competing cameras. In addition, when in Full HD mode, the user can employ the i.Zoom feature to extend the zoom range to approximately 25x while generally maintaining full image quality. That results in an effective zoom range of 24.5 to a massive 613 mm.





*These two pictures give an example of the UX90's zoom range. The picture on the left is fully zoomed in using iZoom; the surface of the moon is clearly visible. The picture on the right was taken from the exact same spot, and shows the field of view when fully zoomed out. You can now see a wide panoramic of the city, and the moon is just a small spot in the center of the frame.*

When in Ultra High Definition mode, the camera delivers an overall zoom range of 35.4mm to 531mm (35mm still camera equivalent). While it's true that this field of view is somewhat tighter than competing cameras' typical 29mm to 31mm field of view, it should also be remembered that previous cameras didn't have UHD at all, so the AG-UX90 remains a tremendous advancement beyond them in terms of the types of images it can create. And having a true optical 15x zoom with an equivalent of 531mm, in Leica Dicomar quality, and recording Ultra High Definition should prove quite useful for nature videography as well as sports, concerts and events where the camera operator can't get in as close as they may wish.

**Iris Range.** The small-sensor cameras were really a miracle of engineering development, fitting true native HD sensors in such a small 1/4.7" sensor size. However, there are some limitations that came from that engineering decision, which could inhibit the cameraperson's ability to use the camera under certain circumstances. One such limitation on the small-sensor camera was that the practical iris range was quite restricted due to the laws of physics and the principle of diffraction. Simply put, the smaller the sensor, the smaller the pixels on the sensor need to be, and the smaller the pixels, the more susceptible they are to diffraction. Diffraction happens when a lens tries to focus a beam of light through a tiny aperture onto a tiny pixel; there comes a point where the aperture is too small and the light cannot be tightly focused. When you exceed that limit, the light scatters, and the overall image becomes soft. What this means in practical terms is that the iris range on a small-sensor camera is limited; on a 1/4.7" HD camera it meant that the smallest physical iris you could use was about f/2.8 before diffraction began to affect the image. The practical working range in terms of physical iris size was just f/1.5 to f/2.8. Panasonic's AG-AC90 utilized a clever integrated ND filter to extend that to a simulated f/6.8. As a veteran AC90 shooter, I can tell you that you never let the iris+ND combination go smaller than f/6.8, or the entire image started to go soft. And f/6.8 was quite limiting, especially outdoors; external ND filters were frequently necessary to maintain proper exposure.

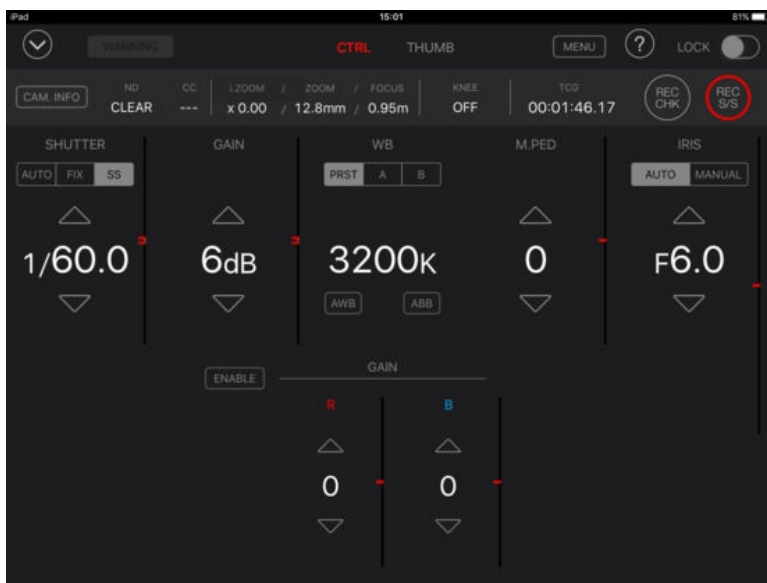
The large sensor of the UX90 relieves much of that limitation. The UX90 can easily achieve f/8.0 while not suffering any resolution loss to diffraction, and even at f/11 there's only the barest hint of diffraction. And that's in UHD mode; in HD it can easily go to f/11 without displaying any effect from diffraction. Furthermore, the AG-UX90 utilizes built-in ND filters that provide up to six stops of filtration, meaning the camera operator has the ability to shoot under light conditions that would require anywhere from f/2.8 to f/64 (in UHD) or f/88 in FHD. This is extremely liberating for the operator, as compared to the restrictions imposed on a small-sensor camera. You can easily maintain a workable iris without resorting to needing external ND filters, even in the brightest daylight shooting conditions.

**Professional Control.** Another area of substantial improvement for the AG-UX90 is in the area of professional control over the camera. Previous low-cost camcorders utilized compact camera bodies which necessarily limited the number of physical controls, switches, and buttons that could be implemented. The AG-UX90 is only modestly larger, which is necessitated by accommodating the larger glass necessary to cover the larger sensor; however, the UX90 makes good use of that additional body space to provide much more manual control for the operator. The UX90 offers full control over the lens with separate rings for focus, iris, and zoom; it offers individual physical built-in neutral density filters for 1/4, 1/16, and 1/64 light transmission (ND 0.6, ND 1.2, and ND 1.8), and it offers more physical control over white balance, autofocus, shutter speed, and other necessary controls. Whereas its predecessor offered three custom-programmable User Buttons with a choice of 15 functions to assign to them, the AG-UX90 offers nine physical User Buttons, with over 40 functions that can be assigned to any of them. The standard-model AG-UX90 actually offers all the same physical controls as the premium-model AG-UX180.

### Remote Control.

The ability to control the camera remotely can determine what types of professional uses and applications the camera is suitable for. The more remote control options (and the lower the price tag of the camera), the more applications you may find for the camera. The AG-UX90 significantly extends

the remote control capabilities far beyond what prior cameras offered. While the AG-UX90 retains full compatibility with the physical “iris/focus/zoom/record” wired remote controllers that previous models used, it also allows for wireless remote control through the use of an optional USB wireless dongle and a free iPad application (the “AG ROP App”), which provides far more extensive control. It can also control zoom, iris, and focus, but it adds the ability to control the shutter speed, the gain, white balance, and even some paintbox-style control over the individual red gain and blue gain channels and the master pedestal.



**Battery Life.** The AG-UX90 is also very power efficient; it draws only 12.2 watts; that's even less power than its HD-only predecessor! The UX90's standard-capacity battery (5900mAh AG-VBR59) provides for nearly seven hours of continuous recording, and larger-capacity batteries are available; the AG-VBR89 has 8850 mAh of capacity and provides for over 10 hours of record time, and the largest battery (the 11,800 mAh AG-VBR118) provides for nearly 13.5 hours of continuous recording!

**Quick Charge Time.** Not only do the batteries for the AG-UX90 last a long time, but the included battery charger is a quick charger. The batteries generally recharge two to three times faster than they last; for example, an AG-VBR118 will provide for nearly 13.5 hours of continuous recording, but will recharge in less than five hours. Using these new quick-charge batteries ensures that with one battery in the camera and just one (additional purchase) battery on the charger, you'll always have battery power available. Or, of course, you could go with a single AG-VBR118 battery, which will probably last through most any shooting day including even overtime hours.

## **Recorded File Formats**

Professional camcorders have frequently required proprietary media and have typically recorded proprietary file formats onto that proprietary media. This is not the case with the AG-UX90; it uses commodity SDXC (or SDHC) memory cards, and records common, non-proprietary industry-standard file formats such as Apple Macintosh-friendly Quicktime .MOV files, Windows-friendly .MP4 files, and cross-industry-standard AVCHD files. This makes file editing much simpler; nearly any modern editing program can edit the UX90's files as-is. There is generally no need for transcoding or converting or otherwise modifying or manipulating the recorded files; with modern editing programs you can actually edit the footage right off the memory cards (although you'll probably see better performance in your editor if you copy the footage onto your computer's internal storage first). This simplification of the recording process offers tangible benefits to the independent shooter or stringer who may be hired by various clients; now the shooter no longer needs to be concerned as to whether the company or its editor will be able to use the footage as recorded. In fact, with the low cost of SDXC memory cards, the shooter is able to actually just hand over the memory card at the end of the shoot day, full of edit-ready footage (and, with the dual card recording capability of the AG-UX90, the shooter can retain a copy or offer the client a duplicate copy as well).

## **Summary**

The state of the professional camcorder is advancing rapidly. Compared to the prior model, the AG-UX90 offers significant advancements in imaging, in controllability, in its suitability for a wider spectrum of jobs that it can do, and does all of this at an even lower price than its predecessor. It is a remarkable camera for its price. While its “big brother”, the AG-UX180, offers more features and performance, it does so at a higher price, and not all users may need the additional power or performance of the more-expensive camera. The AG-UX90 offers a robust feature set, great manual control, and excellent performance at an affordable price point.