Panasonic

AG-DVX200
TECH BRIEF

Autofocus System

By Barry Green, a producer/writer who has authored many books on the operations of Panasonic professional camcorders.

4K PROFESSIONAL

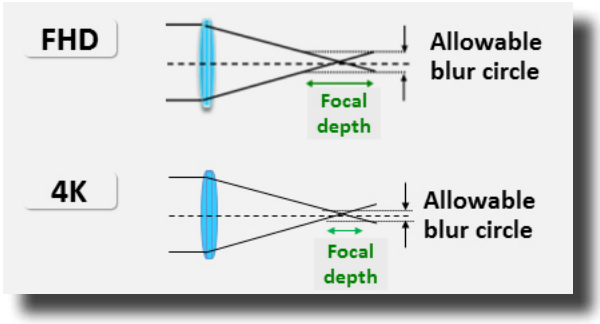
Focusing and 4K

Focus is one of those things that video shooters generally take for granted; after all, it's a fundamental task for any use of a video camera. But consider for a moment the implications of 4K -- with much higher resolution than ever before, now focus becomes more critical than ever. If you miss focus by even just a little bit, you may end up losing all the benefit of having chosen 4K (or UHD) as your shooting format. Slightly misfocused 4K may end up resolving no more detail than properly-focused HD, for example. It's definitely easier to achieve proper focus in HD (or standard-def) than it is to focus 4K (or UHD).

The Confusing Circle Of Confusion

Perhaps some clarity can come from exploring what we mean by "achieving proper focus." A lens is only ever truly focused on one specific plane in space. Technically speaking, anything that is in front of that plane, or behind it, will be out of focus -- although in practice, we're not necessarily so strict. Generally we can say that there will be a certain range in front of and behind the focused plane that will be considered "acceptably sharp" or "in focus"; we refer to that range as the "depth of field."

So what does "acceptably sharp" mean? Generally, it means that the size of any given unfocused point is within a tolerable level. Consider that when a point is focused sharply, it will be rendered at the smallest possible size. If the point is not focused perfectly sharply, it will be rendered as more of a "spot" or "disc". The more out-of-focus that point is, the larger the disc will be. So long as that disc is rendered smaller than our "acceptably sharp" definition, it will still appear to be properly focused; once the size of that disc exceeds the limit at which we consider it to be "acceptably sharp", it crosses over to being defined as "out of focus." The Circle of Confusion is a way to define that size limit; when a point is rendered larger than the Circle of Confusion, it's considered to be out of focus.



Why is this important? Because the higher-resolution sensors used in 4K cameras can resolve so much more detail that a point that might have been considered "acceptably sharp" on an HD camera, would now be considered "out of focus" on a 4K camera. In other words, the Circle of Confusion is smaller for a 4K camera, and the tolerance for out-of-focus errors is tighter. The standards are higher, and the job of achieving proper critical focus becomes harder when using a higher-resolution camera.

Bigger Sensors Require Bigger Glass

Larger sensor cameras generally need larger lenses to properly cover them, and especially when one is talking about a zoom lens. Digital camera (SLR) lenses typically offer only about

a 2x to 4x zoom range; the DVX200's lens offers a full 13x optical zoom range. That means there's a lot of large glass elements in the lens. Furthermore, to keep the lens to a reasonably compact size, the DVX200 employs 17 elements in 11 groups, using sophisticated engineering to move those groups to provide that full 13x zoom range.

For manual focus, this doesn't present much of a problem; so long as the operator can see the detail in the image to judge acceptable sharpness, a lens of such design can be engineered to work properly. But what about autofocus?

Autofocus, Large Sensors, Long Optical Zoom Range, and 4K Resolution

One of the primary design goals for the DVX200 was to produce a camera with acceptably good autofocus performance. The DVX200 is a multi-purpose camera that might be used to cover sports, film weddings, gather news footage, or be put to any number of video purposes. And while precision manual focus is valuable and sufficient for some of those purposes, frankly there are just times when autofocus may be a necessary choice.

Traditional video cameras have offered snappy, responsive autofocus for many years. But traditional video cameras have generally used small sensors, which mean they can use smaller, lighter glass elements in their lenses. And they generally have been FHD (1080P) or less. The small sensor generally uses a wider focal length lens, which results in deeper depth of field, and that deeper depth of field can be conveniently relied on to mask focus errors on the traditional video camera.

The DVX200, on the other hand, combines a large sensor (which requires large, heavy glass) with a long zoom range (which means a lot of large, heavy, complex lens elements moving around), at 4K resolution (which means the focus system must be much more precise than any prior autofocus system). And the large sensor requires longer focal length lenses, which deliver shallower depth of field, so there is less room for focus errors.

Furthermore, the DVX200's autofocus system must be responsive enough to accomodate a wide variety of shooting scenarios. Consider that in an autofocus system, the camera may be tasked with shifting focus from a close-up shot of flower, to mountains on the horizon, and needs to be able to execute that focus shift nearly instantly and with great precision. Compounding that task is that the glass elements are now heavier than ever before, larger than ever before, and need to be accelerated rapidly and then brought to an immediate halt. And, compounding that effort, they need to be brought to a halt with more precision than ever before, because the acceptable Circle of Confusion is smaller for such a high-resolution sensor. This is no small engineering task!

The Micro Drive Focus Unit

To meet these challenges, Panasonic engineered a new Micro Drive Focus Unit, an extremely high-resolution and precise motor control specifically designed to meet the challenges of positioning 11 relatively large and heavy groups of glass into the exact positions they need to be in,

to provide sharp focus on a large high-resolution sensor. Furthermore, when the elements are brought to a halt, the unit employs vibration dampening to ensure that the lens elements are brought to a perfectly smooth, complete stop, with no wobbling or shifting.

Using the Micro Drive Focus Unit, Panasonic has attempted to optimize the focus system to meet three general goals:

1. Fast focus speed
2. Stable focus (meaning, once it locks on a subject, there should be little to no "hunting")
3. Accurate tracking (meaning, as a subject moves closer to or further from the camera, the focus system should track it effectively and should not lose focus.

Using The Autofocus System

Autofocus is not generally the first choice professional videographers reach for; rather it is something that might be relied upon in a fast-moving, fast-changing environment when there are too many tasks to keep track of. But the autofocus system offers several benefits even for the manual focus shooter.

First and foremost, autofocus is able to see and discern details that are difficult for a human operator to observe, especially when using the built-in LCD monitor or viewfinder. Small errors in focus may be easily visible on, say, a 24" production monitor, but may not be easily discerned on a 4.3" LCD panel. However, the autofocus system sees and discerns every pixel; accordingly, it may be able to make more precise judgements than a human operator could. For a static shot, you might just ask autofocus to set the focus for you (by using the Push Auto button).

Additionally, autofocus can be used to establish or track focus on something as routine as a sit-down interview. Using the Area Focus function, the operator can assign an area of the screen to concentrate on (such as where the interview subject's face is); the autofocus system can then attempt to keep track of the subject while she may shift or move in the chair, moves that might cause the subject to move out of the depth of field of the lens's focal plane.

Finally, autofocus might be asked to cope with more complex tasks, such as filming a football game or a live event or wedding dance. These varied events might require a different approach from each other; for example, the football game might require lightning-quick response, whereas the wedding dance might be best served by ignoring much of the field of view and concentrating solely on the couple in the center. To cope with the wide variety of scenarios the autofocus system might be tasked with, Panasonic made the system programmable and customizable.

Customizing The Autofocus System

Recognizing the obvious reality that a sit-down interview might benefit from a very different type of autofocus than a football game, Panasonic has provided several ways to customize the autofocus system, to make it more suitable for any given situation, including:

AREA mode: You can specify what area on the screen you want the autofocus system to concentrate on (and, by default, you're telling the system to ignore the rest of the screen!) Not only can you specify the area, but you can also choose how large of an area to focus on (small, medium, or large). This feature is quite useful for sit-down interviews or for shots where you are consistently framing your subject into a certain section of the display.

Autofocus Area Width: When not using the AREA mode, the focus system generally prioritizes the center of the display for focus purposes. You can choose how wide of an area you want it to consider; you can make it as thin or as wide as you like, thus including the area you want and excluding the area you choose to ignore.

Autofocus Speed: You can adjust the responsiveness of the autofocus system to suit your shooting scenario. Perhaps a fast-moving sport like soccer would require a very fast focus speed, but a more restrained event like a sit-down interview might benefit from a gentler, smoother focus speed.

Autofocus Sensitivity: You can also program how sensitive the focus system is towards re-acquiring its target. You can have it very sensitive (suitable for fast action), or you can have it be more forgiving and restrained. An example might be a case of filming a man-on-the-street interview, where a pedestrian passes between the camera and the subject. If the focus sensitivity was set very high, the focus system might leap from the subject to the pedestrian, and when the pedestrian exits the frame it would then leap back to the subject. Alternatively, you could set the focus sensitivity lower, and in that case the focus system would ignore the brief interruption caused by the pedestrian, and stay focused on your subject. That would likely make for a more pleasant viewing experience for the audience.

Summary

A large-sensor all-in-one camera with a 13x zoom lens presents challenges that haven't been faced before by camcorder manufacturers. Panasonic has engineered a system that can provide suitable autofocus across a wide variety of situations, even taking into account the higher precision necessitated by a large-sensor 4K recording system. Even so, the system can be optimized towards achieving better performance for different shooting scenarios. The best performance will come when the user understands the challenges involved and tailors the focus system towards the particular scenario the user is facing, whether that means simply using the autofocus system to confirm a manual focus position by using the "Push Auto" button, or tailoring the focus area, position, sensitivity and speed to provide an optimal match to the subjects being filmed.

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