Digital Pathology

What to look for when selecting a monitor for the digital pathology workflow

EIZO®

Introduction

Currently, there are no legally binding standards for digital pathology monitors in most countries around the world. And if there are no standards, it's not difficult to know what the best solution is. Which monitor offers the optimal technical specifications? How much do you have to budget in for a monitor that is fit for the future? Without expert assistance, it's difficult and takes a lot of time to choose one.

Since 1968, Japan's EIZO has been developing and producing high-quality monitors and display solutions, often for highly specialized markets where they are deployed in office, video/image processing, video surveillance, air traffic control, industrial, and medical applications. EIZO is one of the leading manufacturers in a related medical field: monitor solutions for radiology. Here, too, maximum precision is of the essence.

To find out what features and properties are important when it comes to selecting monitors for the digital pathology workflow, EIZO reached out to a large number of manufacturers and users from the sector.

The insights gained here, coupled with our many years of expertise and experience in the production and marketing of monitor solutions, enable EIZO to provide you with targeted support – without ever losing sight of the overall performance of your system.

This guide is there to describe the features and properties you need to look for when selecting a monitor for pathology applications.

We would also be happy to provide personal advice and recommendations on the ideal solution to meet your specific requirements.

Advantages of Digital Pathology

The use of digital pathology offers advantages in many respects. Here are a few examples:

- Faster diagnosis and precise, easy-to-read images
- Optimized workflow with no loss of quality
- Increased patient safety thanks to support for accurate assessment of histological slides
- Reduced risk of lost slides
- Facilitates consultations between pathologists and interdisciplinary exchange
- AI has the potential to support diagnostics
- More efficient use of resources

Images and videos can be shared quickly digitally. In this way, any limitations in terms of the physical space and distances between local hospitals, universities (for training and second opinions) and between the workplace and home office are removed. This provides for greater flexibility and efficiency when making a diagnosis. Digital pathology makes telepathology a reality open to many. As an added bonus, digital images do not lose quality over time and cannot be damaged during transport.

In addition, digital tools, such as rulers for sizing, are extremely useful for carrying out a diagnosis.

Resolution

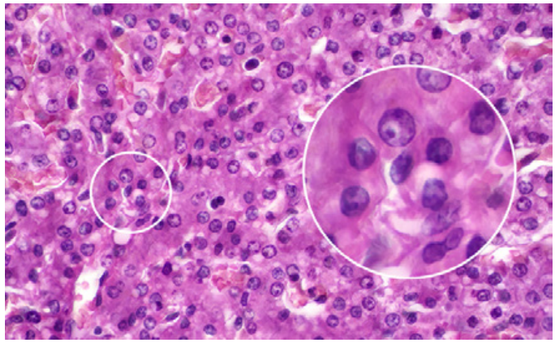
The higher the monitor's resolution, the more details the user will see. Images are less pixelated, have sharper contours, and more content is displayed at one time.

A monitor's resolution indicates the number of pixels that make up the image on the screen. A pixel is the smallest element in a digital image. A monitor's resolution is measured by the number of pixels (width x height) used to generate the monitor image.

The higher the monitor's resolution, the more details the user will see. More image content can be displayed at one time on large screens with a high resolution. The images are less pixelated and exhibit clearer contours. If the resolution is too high and the screen size is too small, texts, images, and tools will be too small to read and use effectively. To adjust for this, users often change the scaling in the operating system settings, leading to imprecise images and unwanted image artifacts, however.

When viewing a digitally captured image from a WSI (whole slide image) scanner, for instance, a high resolution is recommended to maintain an optimal level of detail and information for pathological diagnosis (min. 4 MP (2560x1600) with a 27-inch monitor, 6 MP (3280x2048) with a 30-inch monitor, and 8 MP (3840x2160) or higher with a 32-inch monitor).

A pathologist will frequently move the whole slide image (WSI) during a digital examination, meaning the image has to be reloaded multiple times. Powerful graphics cards are required to ensure this happens quickly and seamlessly. We recommend using EIZO MED-XN graphics boards here.



Screen Size

The physical workspace and the user's field of view are two factors that need to be considered when selecting the screen size. For digital pathology applications, 27-inch to 32-inch widescreen monitors are recommended to fill the user's natural field of view.

A 24-inch monitor is too small to fill the user's natural field of view, whereas a larger monitor with a 55-inch screen, for example, would force the user to constantly move their head to view the full image.

Experience has shown that users working in pathology are most comfortable with a 27-inch to 32-inch monitor because it reduces the need for image scaling. The result of this would be imprecise images and unwanted image artifacts.

A monitor's aspect ratio is linked to the resolution. It represents the proportionate relationship between a display's width and its height. The aspect ratio is expressed by two numbers separated by a colon (for example, 4:3). The closer the numbers are to each other, the more square in shape the display will be (4:3, for example). The farther apart the numbers are from each other, the wider the display will be (for example, 16:9).

In digital pathology applications, an aspect ratio of 16:10 provides an image very close to what you would see under a microscope and similar to a human's natural field of view.

Workstation

The human eye can only take in a limited amount of data. To get the most accurate information out of each image, you need to consider the screen size, resolution, and distance between the monitor and the user at the workstation when selecting a monitor. The screen size should be chosen in relation to the viewing distance.

The screen size and resolution of the monitor are equally important when it comes to finding the right display for a pathological workstation. Increasing the resolution, but not the screen size, can cause text, images, and tools to be displayed too small to read and use effectively.

Image Brightness

Monitors with a brightness higher than 300 cd/m^2 are better suited for brightly lit rooms with lots of ambient light.

The brightness, or luminance, of a screen is generally measured in candelas per square meter (cd/m^2) (one candela is the luminous intensity roughly equivalent to that of a common candle).

A just-noticeable difference, or JND, is the smallest change in color and brightness that the human eye can still perceive . The brighter a monitor is, the more JNDs will be displayed. This is a crucial factor because the more JNDs a monitor can display, the more likely it is that minute differences within an image will be detected.

The Federal Association of German Pathologists recommends monitors with a nominal image brightness of at least 300 cd/m^2 for pathological diagnostics. This corresponds approximately to the perception through a conventional microscope. In order to achieve a permanently constant brightness, EIZO even recommends monitors that can generate a much higher brightness in order to have reserves for the ageing of the device and brighter working environments.

In a bright room, the monitor brightness should be significantly higher than 300 cd/m^2 in order to detect a sufficient number of JNDs.

Contrast

A dynamic contrast ratio (15000000:1, for example) is typically used for televisions for home use, while static contrast ratios are normally used for medical monitors.

A monitor's contrast is the ratio between the darkest blacks and the brightest whites. For example, a static contrast ratio of 1000:1 means that the brightness of a completely white image is 1000 times higher than the brightness of a completely black image. Contrast is important for ensuring that the pathologist can see details such as cell walls and boundary layers in images.

Screens have inherently low light scattering. Because of this, there may be differences between monitors when it comes to how black the darkest blacks are. The brightness of a monitor therefore does not tell the whole story.

The two main methods to obtain the contrast ratio are by measuring the static contrast ratio or the dynamic contrast ratio. Static contrast is the ratio of white to black on a monitor without adjusting the background illumination (brightness). The dynamic contrast is determined by first measuring the white level at the maximum backlight setting and then the black level at the minimum backlight setting. Most monitors cannot display an image when the backlight level is set to maximum or minimum.

Measuring the static contrast ratio gives a much more reliable indication of the contrast that can be achieved within a single image.

To ensure good differentiability in dark and bright image areas, screens with a nominal contrast ratio of at least 1000:1 (static contrast ratio) are recommended for pathology diagnostics. The Pathogen Association advises using a medium brightness and contrast setting.

A brighter environment can reduce the real light ratio (the ratio between black and white in the real world) because light reflected from the monitor masks the darker tones. In such cases, reducing the ambient light at the front of the monitor to a minimum is recommended.

Image Homogeneity and Refresh Rate

It is important to balance out irregular luminances on the monitor area to ensure that the image is displayed uniformly, no matter where it is on the screen.

Homogeneity refers to the consistency of brightness and color across the entire display. It is important that fluctuations and irregularities are leveled out across the entire monitor area to create a uniform image across the full display. This is the only way to ensure the user always sees the same image, no matter where it is on the monitor. The DUE (Digital Uniformity Equalizer) functionality enables RadiForce series medical monitors to compensate for differences in brightness and color.

Inhomogeneity causes an image to appear differently depending on its position on the screen. This could result in the user having to move the image on the monitor in order to obtain all the information from it.

Standard office monitors do not offer a digital homogeneity control option. They typically feature inhomogeneous illumination and exhibit blurring or shading. While this is not critical in office applications, homogeneous illumination is essential for diagnostically relevant image content.

With DUE

Without DUE

The refresh rate of a monitor defines how often a new image is drawn per second, measured in hertz (Hz).

Most WSI scanners typically capture a single image plane of a slide at a very high resolution. Some scanners are able to capture multiple images in different layers and combine them to create a single 3D image. A suitably high refresh rate makes it easier to navigate within an image and move between layers.

For medical monitors, EIZO recommends a refresh rate of 60 Hz.

Calibration

Medical devices should undergo appropriate quality control and calibration before leaving the factory and throughout their service life. Routine quality control ensures that pathological diagnoses are consistent and reliable. As a result, users trust the information they see on the screen and there is a lower risk of misdiagnosis. Using monitors that can be calibrated ensures that future standards can also be met.

There are two types of calibration: hardware and software calibration. In the case of hardware calibration, the settings are adjusted directly on the monitor, including, among other things, the brightness, white point, and gamma values. Any required changes are written directly to the monitor's LUT (look-up-table) to ensure precision calibration. In the case of software calibration, the necessary adjustments are made in the graphics board that controls the monitor. As a result, the monitor must always be used with the same computer, or the settings will be lost. Hardware calibration offers a higher level of precision than software calibration.

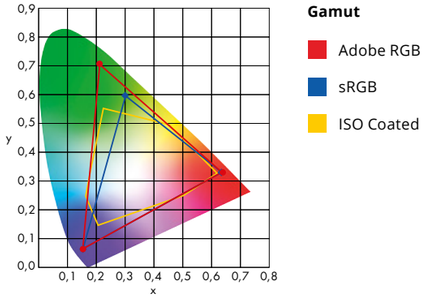
The brightness of a monitor decreases over time. However, it is important to keep the brightness/luminance of a monitor at a consistent level. Regular quality control and calibration ensure a constant level of display precision and uniform image reproduction across multiple locations.

Color

It is important for the work of pathologists that all monitors meet the established color standards.

Since there are currently no standards for color reproduction in pathology, it is important for quality checks to be performed regularly. Predefined color standards such as sRGB, for example, should be used as a guide. The monitors should be also calibrated taking into account the relevant light conditions. This can easily be achieved by using self-calibrating monitors.

The most important gamuts for image capture and rendering are sRGB, Adobe RGB, BT.2020, and DCI P3. In most cases, devices such as monitors, printers, and digital cameras are configured to reproduce the sRGB color gamut as accurately as possible. This is also true with a number of applications. If two devices use different color palettes (for example, a WSI scanner and a monitor), the color will be rendered differently.



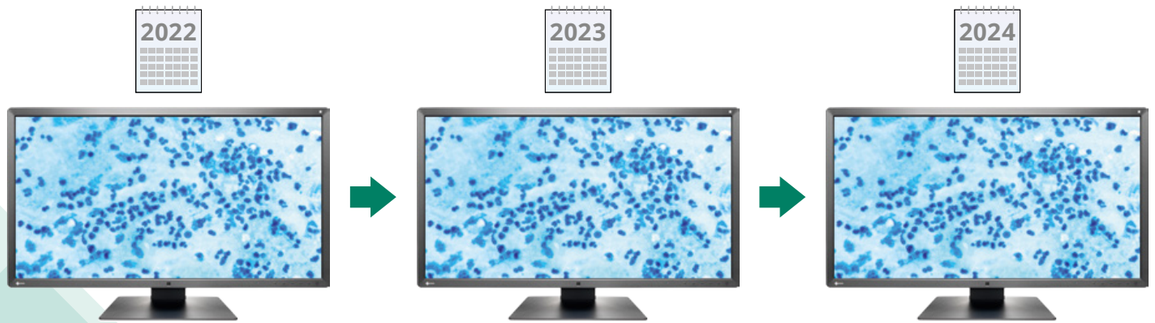
Durability

Medical monitors have a much longer service life than standard monitors. This means they can be in heavy use over a long period of time. They are designed this way because it is important that they deliver consistently high performance and because the monitors will ideally be replaced at the same time that other digital pathology equipment, such as the WSI scanner, is as well.

Monitors that can produce higher brightness levels than are currently required are recommended because they offer a buffer in case stricter brightness requirements are established in the future.

Extremely long manufacturer's warranty: Five-year warranty with on-site replacement service

RadiForce monitors are designed for a long service life, typically well beyond the five-year warranty period. EIZO provides an extra-long five-year warranty on its RadiForcemonitors. In combination with the on-site replacement service, EIZO monitors offer the highest possible investment security without any service costs.



Quality Control Software

Quality control software for medical monitors helps in performing monitor validation tests according to national and international quality standards and in adapting the monitor to the specific working environment.

Server-based solutions also enable central administration, making it possible to efficiently manage the quality of all monitors connected in the network. They allow all information that is collected to be consolidated at one centralized location, make creating reports easier, and help resolve problems where they occur. In addition, future standards can be easily implemented to ensure that they are applied to all monitors.

Summary

Resolution
The higher the monitor's resolution, the more details the user will see. Images are less pixelated, have sharper contours, and more content is displayed at one time.

Screen size
For digital pathology applications, 27-inch to 32-inch widescreen monitors are recommended to fill the user's natural field of view.

Workstation
To get the most accurate information out of each image, you need to consider the screen size, resolution, and distance between the monitor and the user at the workstation when selecting a monitor.

Image brightness
The Federal Association of German Pathologists recommends monitors with a nominal image brightness of at least 300 cd/m² for pathological diagnostics. This corresponds approximately to the perception through a conventional microscope. In order to achieve a permanently constant brightness, EIZO even recommends monitors that can generate a much higher brightness in order to have reserves for the ageing of the device and brighter working environments.

Contrast
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Image homogeneity
Inhomogeneity causes an image to appear differently depending on its position on the screen. This could result in the user having to move the image on the monitor in order to obtain all the information from it.

Refresh rate
For medical monitors, EIZO recommends a refresh rate of 60 Hz.

Calibration
Routine quality control ensures that pathological diagnoses are consistent and reliable. As a result, users trust the information they see on the screen and there is a lower risk of misdiagnosis.

Color
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Durability
Medical monitors have a much longer service life than standard monitors. This means they can be in heavy use over a long period of time.

Quality control software
Quality control software for medical monitors helps in performing monitor validation tests according to national and international quality standards and in adapting the monitor to the specific working environment.

When using EIZO monitors for pathology, it is recommended to evaluate the entire system including the scanner.

Do you have any questions?

We will be happy to advise you when selecting the right monitor solution and provide you with a free test unit for evaluation purposes on request.

Find your local sales partners or EIZO contact persons: **eizo.eu/contact**