

## Three-dimensional imaging technology offers promise in medicine

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### Summary

Medical imaging plays an increasingly important role in the diagnosis and treatment of disease. Currently, medical equipment mainly has two-dimensional (2D) imaging systems. Although this conventional imaging largely satisfies clinical requirements, it cannot depict pathologic changes in 3 dimensions. The development of three-dimensional (3D) imaging technology has encouraged advances in medical imaging. Three-dimensional imaging technology offers doctors much more information on a pathology than 2D imaging, thus significantly improving diagnostic capability and the quality of treatment. Moreover, the combination of 3D imaging with augmented reality significantly improves surgical navigation process. The advantages of 3D imaging technology have made it an important component of technological progress in the field of medical imaging.

**Keywords:** Three-dimensional imaging technology, endoscope, augmented reality, surgical navigation

### 1. Introduction

Medical imaging has played an important role in the diagnosis and treatment of disease in today's world. Medical imaging technology is also needed in medical research and education. Medical equipment currently has two-dimensional (2D) imaging systems that offer 2D slices of whatever or whoever is being examined. Although data of this type can satisfy clinical requirements to a large extent, they poorly depict pathologic changes in 3 dimensions. With the rapid development of three-dimensional (3D) imaging technology, medical imaging is transitioning from 2D patterns to 3D models, thereby providing better visual images and more accurate quantitative results. The advantages of 3D medical imaging, including obvious depiction of spatial locations and logical reasoning, have made it an important component of technological progress in the field of medical imaging.

The use of 3D imaging technology in endoscopy is a typical example. The principle of stereo vision is that different images are observed by the left and right eyes

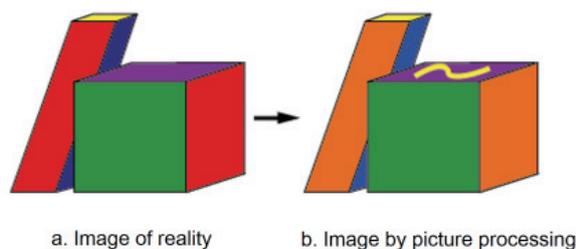
due to parallax and these images are then overlapped on one another by the human brain, thereby resulting in forward and backward, up and down, left and right, and far and near views of an object (1). A 2D endoscope has one camera but a 3D endoscope has two cameras. Two separate video signals from slightly different angles are processed by stereo display technology and then shown to observers as stereo images. One advantage of a 3D endoscope is easier surgical navigation. The information gathered by a conventional 2D navigation system cannot be directly interpreted and understood, creating a large gap between conditions in an actual patient and their depiction by an imaging system (2). This disadvantage necessitates constant comparisons of the surgical field and a displayed image, thus leading to frequent hand-eye transitions. A 3D endoscope overcomes this drawback in large part and 3D endoscopes have widely been used to perform minimally invasive surgery (3,4). A 3D endoscope is a key component of the da Vinci surgical robot (5). A surgeon sits at an imaging workstation away from operating table, where he or she operates the system's robotic arms while looking at a monitor that presents 3D images of the surgical site. The use of 3D imaging technology allows the da Vinci surgical robot to perform many complicated procedures that could not be performed with a 2D endoscope.

A feature of 3D imaging technology is its depiction of depth since that technology depicts an object as it

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**Figure 1. Schematic diagram of 3D imaging technology combined with augmented reality.**

would normally appear. This technology has limited use since it is not necessary if an object can be viewed with the naked eye. In the aforementioned example of an endoscope, 3D imaging technology is used to view something that is not visible to the naked eye. Thus, an object can be viewed as a 3D image, which is something that humans are familiar with. Three-dimensional imaging technology is useful for viewing an object that cannot be seen directly by the naked eye, but this technology has limited use in medicine. A more useful approach is to combine 3D imaging technology with augmented reality (2,6). Three-dimensional imaging technology produces an image equivalent to that seen with the naked eye, and an actual scene can be depicted virtually using a PC. For example, a surgeon can be shown an image during surgery while keeping his or her eyes on his or her hands. Combining 3D imaging technology with augmented reality allows useful images from that technology to be used during surgery.

Three-dimensional information during surgery can be conveyed by combining 3D imaging technology with augmented reality. For example, a mark can be displayed on an actual object, as shown Figure 1. Color

correction can also be done, such as the change in color from red to orange in the same figure. In addition, a surgical procedure can be shown in 3 dimensions. Three-dimensional imaging technology can provide a surgeon with a wealth of information during surgery. Thus, human error during surgery can be reduced. Use of 3D imaging technology in medicine will presumably increase significantly in the future.

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