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Next–Generation Surgical Instruments with Real-Time Detection

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Precision during surgery is essential, as accidental injury to nerves, blood vessels, or surrounding tissues can lead to serious complications. Surgeons often depend on visual observation and tactile sensation, which may not always reveal delicate or hidden structures. This limitation highlights the need for intelligent support systems in surgical practice. The present work introduces the concept of sensor-integrated surgical instruments that can provide real-time identification of different tissues during operations. By using a combination of RGB color sensing, infrared (IR) reflectance, and ultrasonic depth analysis, the system is capable of distinguishing between muscle, nerves, and blood vessels. The instruments are designed to give immediate feedback to the surgeon, enabling safer dissection and minimizing the risk of unintentional damage. While the concept is demonstrated on scissors, it can be applied to a wide range of surgical tools such as scalpels, forceps, and clamps, or adapted to create new intelligent instruments. This approach represents a step toward safer, more precise, and technologically advanced surgeries, ensuring better outcomes for patients.

Keywords: RGB sensing, Surgical safety, Smart instruments, Tissue identification, Ultrasonic detection

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