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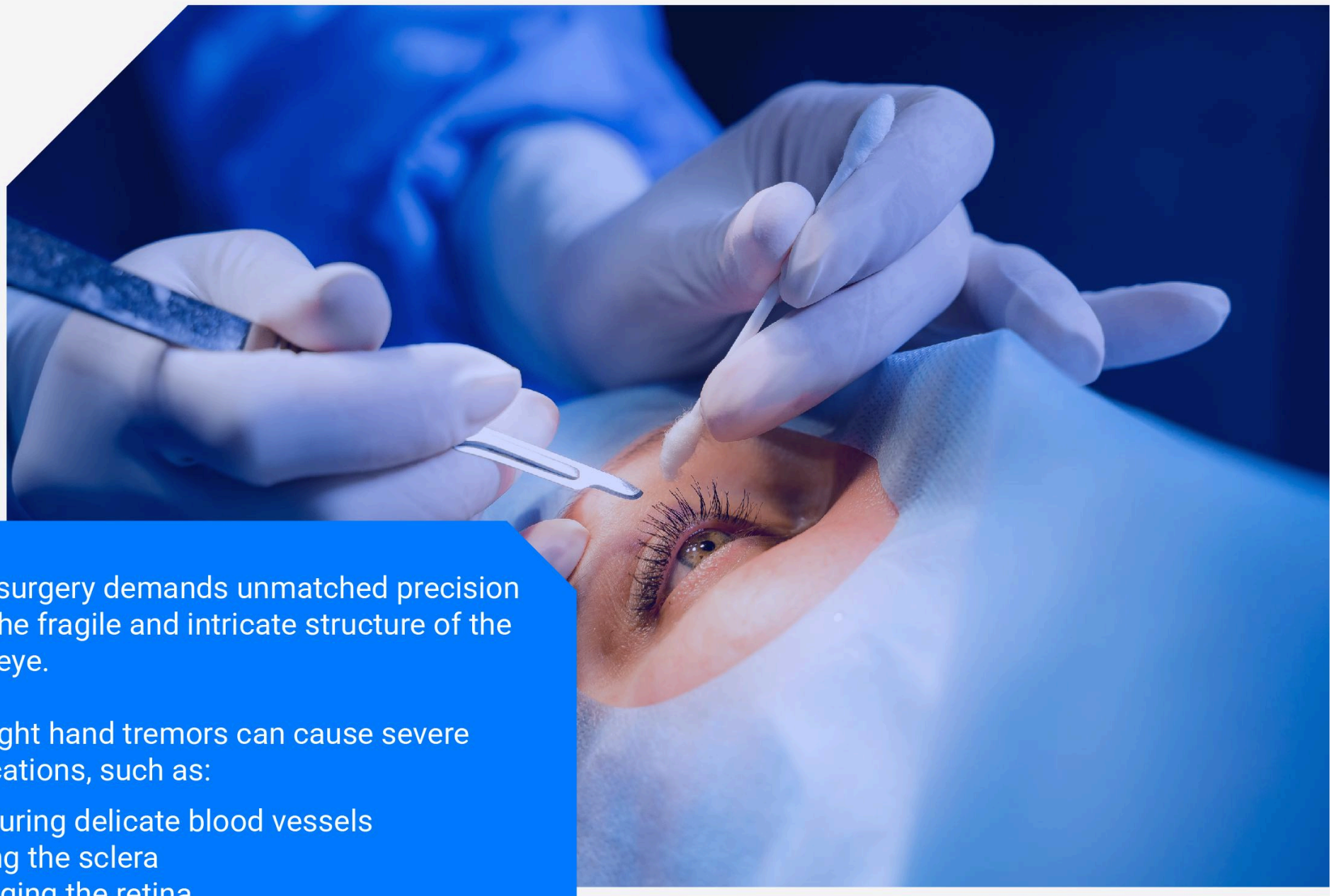
The Critical Need for Precision in Retinal Surgery



Retinal surgery demands unmatched precision due to the fragile and intricate structure of the human eye.

Even slight hand tremors can cause severe complications, such as:

- Puncturing delicate blood vessels
- Tearing the sclera
- Damaging the retina

CMU's Innovative Solution

Researchers at Carnegie Mellon University (CMU) developed a handheld robotic arm designed to assist surgeons with high-precision tasks.

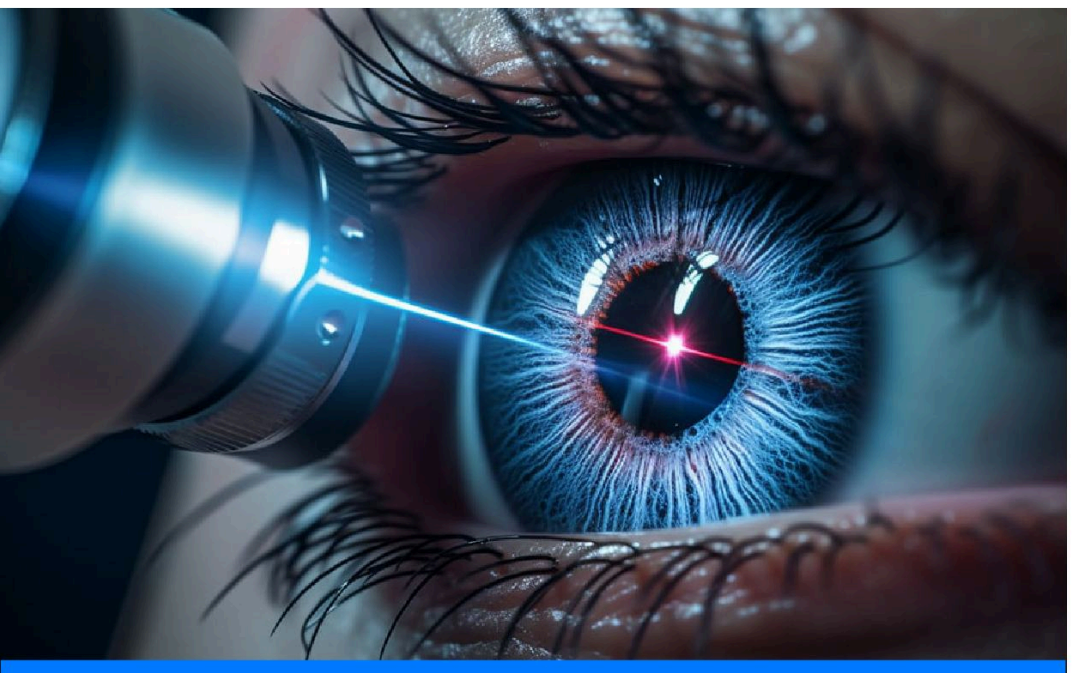
Key Features

Six degrees of freedom for controlled movement	Computer vision integration to identify ‘safe zones’	Real-time processing with RedHawk™ software

This cutting-edge innovation merges mechanical engineering, robotics, and real-time control systems to revolutionize microsurgery.

Challenges in Retinal Surgery

Performing retinal surgery is extremely risky due to the eye's sensitivity and minute anatomy.



The team at CMU tackled these challenges with an innovative blend of robotics, AI, and real-time control software.

Some of the key challenges include:

Hand Tremors:
Even slight involuntary movements can disrupt the procedure.

Precision Control:
Retinal surgeries require accurate targeting of microscopic blood vessels.

Real-Time Synchronization:
The robotic system must process feedback instantly to adjust movements dynamically.

Safe Navigation:
Computer vision algorithms must analyze real-time retinal images to avoid critical areas.

High-Performance Processing:
The system must operate at high speed without any delay.

The Technological Solution

Core Technologies Powering the Robotic Arm

Jetson Nano
(Compact AI-based computing unit)

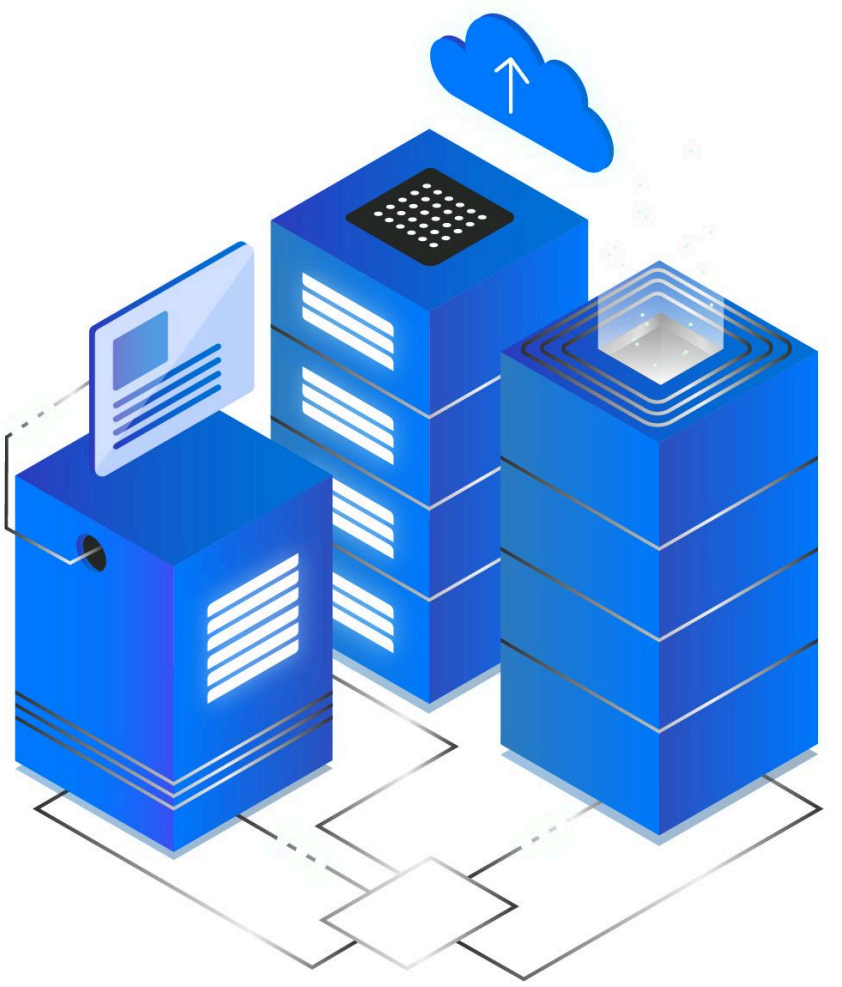
- Processes computer vision & machine learning models
- Handles real-time data input and output

RedHawk Real-Time Software

- Ensures precise motor control with up to 1 kHz frequency
- Allows seamless real-time operation of computer vision & motor commands

Advanced Computer Vision

- Identifies safe zones in the retina for accurate surgical navigation
- Maintains needle stability by compensating for hand tremors



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Key Benefits of the Robotic System

Enhanced Surgical Precision

- Eliminates hand tremors for steady needle positioning
- Reduces risk of unintended damage

Real-Time Performance

- Motors operate with perfect synchronization
- High-frequency control ensures surgeon's intent is precisely executed

Scalability & Versatility

- Can be adapted for brain tumor removal and other microsurgeries
- Modular design allows future upgrades

Cost-Effective Development

- Uses commercially available hardware
- Affordable for academic research & clinical trials

Paving the Way for Safer Microsurgeries

The CMU robotic arm showcases the power of robotics & real-time computing in surgery.

Future Developments

Integrating advanced machine learning for predictive control.

Further clinical trials for real-world implementation.

By combining robotics, computer vision, and real-time software, this handheld robotic arm represents a groundbreaking advancement in microsurgical technology.

RedHawk real-time software and commercially available hardware like the Jetson Nano allowed the team to develop a high-performance system at a relatively low cost. This made the project accessible for academic research and potential future clinical trials.

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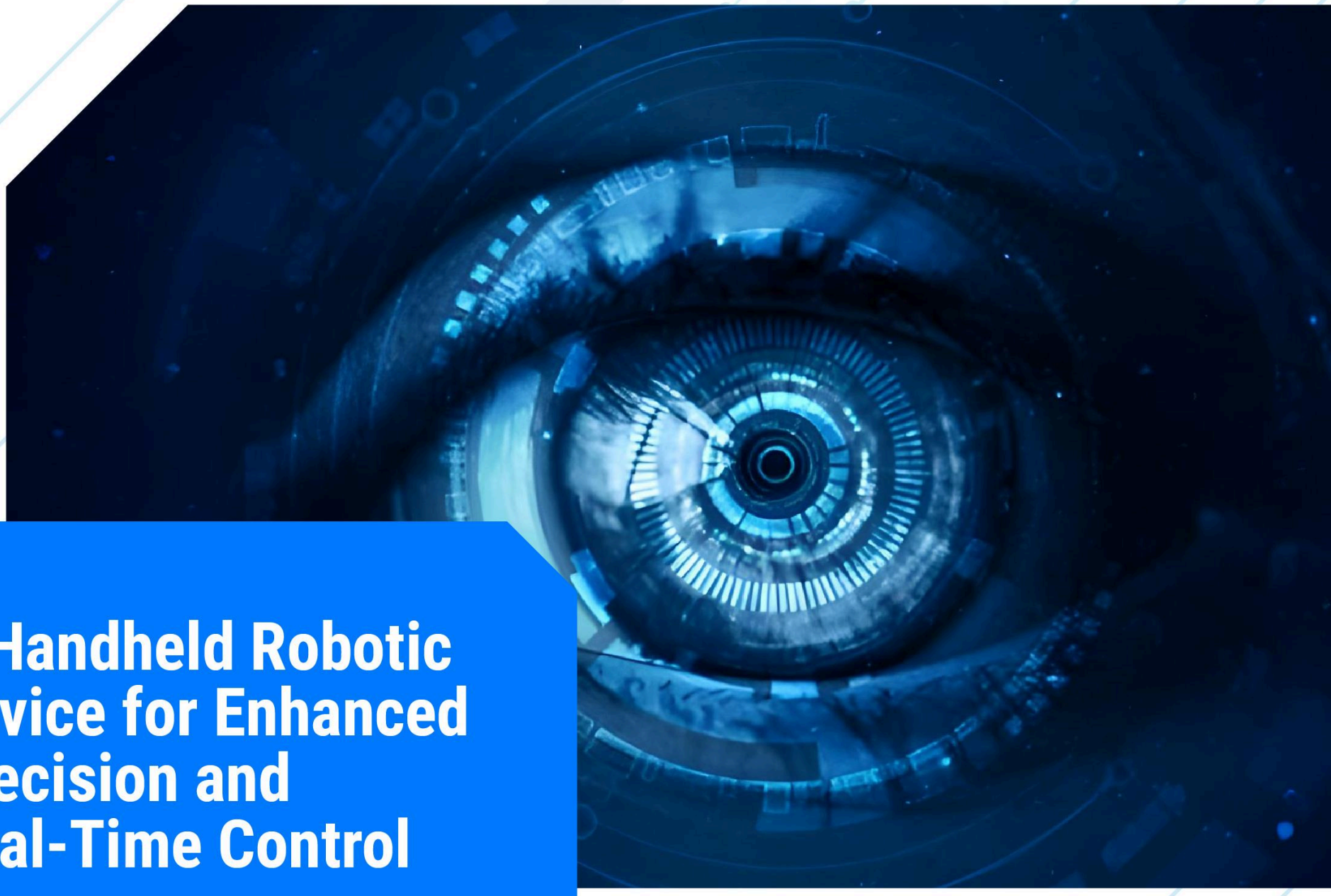

A Handheld Robotic Device for Enhanced Precision and Real-Time Control

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