International Journal of Humanities Social Science and Management (IJHSSM)
Volume 5, Issue 5, Sep.-Oct., 2025, pp: 589-599 ISSN: 3048-6874
www.ijhssm.org

Wireless handgun arthroscopy with spectral and position correction

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Date of Submission: 13-09-2025 Date of Acceptance: 27-10-2025

ABSTRACT: This handgun-style endoscopic device features spectral analysis, position correction, and a viewing window. Its structure includes an endoscope connector, universal cord, control section, and insertion tube.It is powered by an ultra-wide-angle lens, an image sensor, and an LED when used as a general light source. Filters capable of expressing different contrasts between lesions and normal tissues through near-infrared spectral analysis of short-wavelength LEDs in the 700-1,100 nm range were selected, enabling color-coded near-infrared expression. Specific symptoms of the affected area were identified through near-infrared spectral analysis, with the near-infrared wavelength range capable of distinguishing between abnormal and normal tissues determined. Filters can be easily replaced as needed, and the jack-type design ensures convenience. Position correction was difficult to interpret because the direction of gravity in images acquired from the video endoscope did not match the direction of gravity in the workspace. However, accelerometers and gyro sensors were used to ensure that the endoscopic image's gravity was always aligned with the designated location. Using the correction, the acquired images were used to detect abnormal areas and facilitate the assessment of the affected area's progression.

The video endoscope's image correction device receives data from gyro sensors attached to the handheld endoscope and calculates the rotation angle using a Kalman filter and postprocessing. A large video monitoring and viewing window is attached to the main unit, allowing medical staff to conveniently view the data on a small LCD screen directly attached to the arthroscope during surgery. This allows for real-time dual display. Detected images of unusual symptoms are automatically saved and stored in a database for analysis. For wireless communication, a digital electronic camera module and a UWB communication module, which transmit high-quality image information sensed by the endoscope, were combined to establish a wireless video communication system that uses UWB-based communication between the transmitter and the monitor connected to the transmitter. In sensing using a digital electronic camera, high-definition endoscopic management information was wirelessly transmitted to a UWB communication module and played on a PC on the wall of the operating room, and endoscopic videos stored in the memory of the digital electronic camera module were wirelessly transmitted via the UWB communication module.

KEYWORDS: Actuator, Microprocessor, Enginehead, L293D Current Amplifier, IRF 3205 MOSFET.

I. INTRODUCTION

For digital endoscopes, LEDs are used as low-power light sources. To ensure stable operation, a constant-current LED driver was designed. A cylindrical design was required. Because the narrow diameter prevents all components from being mounted on a single PCB, the design allowed for stacking[1].

The system incorporates a built-in power supply, a structure capable of receiving power from a power control module, and a device for controlling the light source to identify tissue abnormalities. This device utilizes the fluorescence properties of tissues for arthroscopy. When a near-ultraviolet light source in the 375-478 nm wavelength range is projected into the body, tissues naturally fluoresce[2]. The differences in fluorescence between abnormal and normal tissues are visualized, allowing tissue differentiation[3].

However, the use of ultraviolet light carries the risk of causing abnormalities in human tissues or genetic structures[4]. Tissue composition analysis using near-infrared or infrared light is primarily used in the in-vitro stage, a secondary examination after tissue sampling during routine endoscopic examinations. This requires expensive equipment. Electronic endoscopes, the most widely used endoscopes, consist of an insertion unit that enters

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the body to receive images, a control unit for adjusting the insertion unit, a connection unit that connects the imaging center to the light source, a processing unit for processing image signals, and an output unit for outputting the processed images[5].

The scope's terminal contains a built-in lens and CCD sensor, which inputs image signals. Light from an external light source is transmitted via optical fiber.

The received images are transmitted to a monitor by the image signal processing unit, which then processes the signals[6],[7]. Electronic endoscopes utilize high-resolution, miniaturized CCD chips to provide real-time images for both diagnosis and treatment. Images transmitted from the CCD chip can be displayed on a monitor and stored as medical diagnostic data using a photographic device or video printer[8]. The present invention aims to develop a system capable of identifying abnormalities while maintaining clear, high-resolution color images by utilizing a near-infrared filter in the endoscope's light source system. Since the light source of an arthroscope cannot be directly irradiated to the terminal via a lamp, it is irradiated into the body from an external light source device, with a color filter and a near-infrared filter installed in a circular axis shape at the scope connection[9],[10].

II. Materials and Methods

High-definition endoscopic image data is wirelessly transmitted to a UWB communication module using digital electronic cameras for sensing and playback on a PC. Endoscopic videos stored in the digital electronic camera module's memory are also wirelessly transmitted via the UWB communication module.

Medical staff can conveniently display high-definition endoscope image data wirelessly on a display. A UI structure and UI software are implemented for analyzing and monitoring image data using near-infrared filters, facilitating the detection of specific symptoms, such as abnormalities and inflammation, in patients' affected areas.

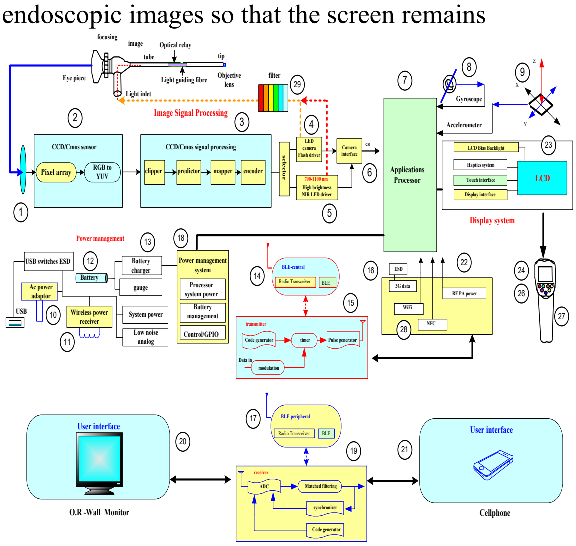
Specific symptoms in affected areas are identified using near-infrared spectroscopy analysis to determine the near-infrared wavelength range that can distinguish between abnormal and normal tissues within the body. This is then applied to the filter. In the present invention, a device is developed that uses an accelerometer and gyro

The endoscope power control module is a circuit that supplies power to digital endoscopes. It is designed to supply power to the image sensor, image processor, communication module, LED FLU, and other components[11]. Its handheld design features a viewing window attached to the body for ease of use, and it utilizes a gyroscope to maintain horizontal alignment[12],[13].

In addition to the components mentioned above, various other components are required for the design of a digital endoscope[14]. Additional components requiring power sources include numerous op-amps. A power control module is necessary to ensure a stable power supply for these components. This circuit is designed for debugging normal operation using a UWB communication module for high-capacity communication, while Bluetooth communication is possible for small-capacity image processing[15],[16].

Depending on the purpose, it can be connected to a PC via a USB port, and a BNC port is built in for direct connection to equipment such as an oscilloscope or spectrum analyzer[17]. This module is designed to measure the performance of wired and wireless UWB communication modules[18],[19],[20].

sensor to correct the gravitational direction of endoscopic images so that the screen remains



aligned at a designated location. Using the acquired images, an image processing algorithm is developed to detect abnormal areas and quantify the extent of the affected area's progression. This algorithm is then validated using arthroscopic images. It outputs to a large-scale video monitoring and a small LCD screen directly attached to the

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arthroscope, allowing real-time viewing on a dual display screen, and automatically saves detected specific symptom images and then converts them into a database for analysis.

Figure 1 illustrates the proposed method in this study. When used as a general light source, the system is driven by an LED. Filters capable of differentiating the contrast between lesions and normal tissues are selected through near-infrared spectral analysis of the short-wavelength 700-1,100 nm LED, enabling color-coded near-infrared images.The near-infrared wavelength range was determined, allowing for easy replacement of individual filters as needed. The jack-type design ensures convenience.Position correction utilizes accelerometers and gyro sensors to ensure that the endoscopic image's gravitational direction is always aligned to the designated position.

A large image monitoring and viewing window is attached to the main unit, allowing medical staff to conveniently view the image in real time on a small LCD screen attached directly to the arthroscope during surgery. Detected images of unusual symptoms are automatically saved and stored in a database for analysis. A wireless video communication system was developed by combining a Bluetooth (low-capacity) and UWB (high-capacity) communication module that transmits high-quality image information sensed from a digital electronic camera module and an endoscope. This system communicates UWB-based with a monitor connected to the transmitter.

High-quality endoscopic image information from a digital electronic camera is wirelessly transmitted to the UWB communication module and played back on a PC mounted on the operating room wall. Endoscopic video stored in the digital electronic camera module's memory is also wirelessly transmitted via the UWB communication module. Symbol 1 is a lens, symbol 2 is a CCD-CMOS sensor, symbol 3 is a CCD-CMOS sensor signal processing, symbol 4 is a general lighting LED, symbol 5 is a near-infrared LED driving device with a wavelength of 700-1,100 nm proposed by the present invention, symbol 6 is a camera interface, symbol 7 is an application processor, symbol 8 is a gyroscope sensor that performs a position correction function proposed by the present invention, symbol 9 is an accelerometer that controls the speed of position correction and attitude correction proposed by the present invention, symbol 10 is an AC adapter, symbol 11 is wireless power, symbol 12 is a battery of wireless arthroscopy, symbol 13 is a battery charger, symbol 14 is a small data transmission and reception Bluetooth transmitter of an auxiliary concept, symbol 15 is UWB-T, symbol 16 is a wifi-module, symbol 17 is a small data transmission and reception Bluetooth receiver of an auxiliary concept, symbol 18 is a power management system, symbol 19 is UWB-R, symbol 20 represents an OR-wall monitor, symbol 21 represents a cell phone, symbol 22 represents RF power, symbol 23 represents a handgun type LCD view proposed in the present invention, symbol 24 represents an LCD view proposed in the present invention, symbol 25 represents a handgun type control button proposed in the present invention, symbol 26 represents a handgun type handle battery compartment proposed in the present invention, symbol 27 represents a handgun type handle battery compartment proposed in the present invention, symbol 28 represents NFC, and symbol 29 represents a filter proposed in the present invention.

In other words, the most appropriate image data transmission method for transmitting high-definition images sensed from an endoscope uses UWB communication technology. This is because high-definition images require large amounts of data to be transmitted, and UWB communication has an ultra-wideband frequency range that enables a large amount of data to be transmitted at once.

II.System Composition and Principal

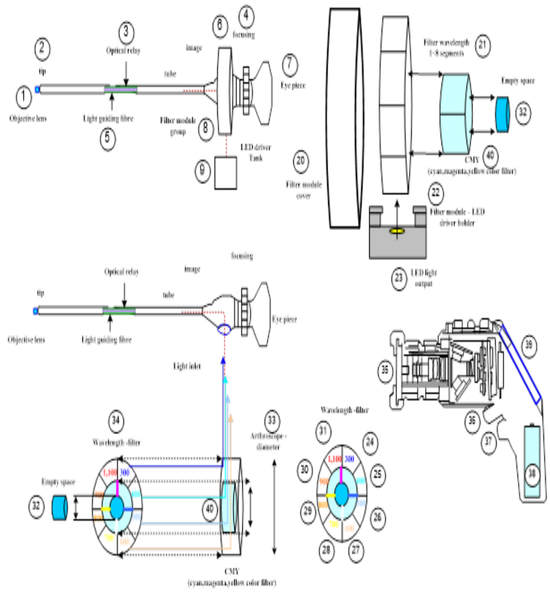

Figure 2: Wireless arthroscopy with spectral analysis, blocking filter, and viewing window

Basically, the light source is an LED. The light source lamp and scope are equipped with an

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ultraviolet (UV) blocking filter and a cyan,magenta, and yellow (CMY) color filter. UV can cause cell mutations, and the color filter compensates for the CMY. The image signal is corrected by sequentially rotating the three color filters.
Continuously transmitted light reaches the CCD, forming a color image signal. The image signal processor synthesizes the colors to complete the image. Spectrum analysis utilizes spectral measurements to determine the reflectance spectrum, which is useful for analyzing the components of a sample. Symbol 1 is the objects lens, symbol 2 is the tip, symbol 3 is the optical relay, symbol 4 is the focusing, symbol 5 is the light guide fiber, symbol 6 is the high-power light source that emits up to near-infrared light in the method proposed in the present invention, and inside it holds the arthroscope axis, next is composed of color filters, next is composed of ultraviolet filters, etc. Symbol 7 is the eye piece, symbol 8 is the filter module group, symbol 9 is the LED driver that can output up to near-infrared wavelengths, symbol 20 is the filter module cover, symbol 21 is composed of 8 filter wavelengths from 300 to 1,100, symbol 22 is the filter module LED driver holder, symbol 23 is the high-power LED light output, symbol 32 is the empty space, and symbol 40 is composed of a CMY filter (cyan, magenta, yellow). Symbol 34 represents a wavelength filter, symbol 33 represents an arthroscope diameter, symbol 24 represents a blue filter, symbol 25 represents a 300 nm filter, symbol 6 represents a 500 nm filter, symbol 27 represents a 600 nm filter, symbol 28 represents a 700 nm filter, symbol 29 represents an 800 nm filter, symbol 30 represents a 900 nm filter, and symbol 31 represents an 1,100 nm filter. Symbol 35 represents a holder for symbol 7, symbol 36 represents a zoom-in switch according to the present invention, symbol 37 represents a zoom-out switch according to the present invention, symbol 38 represents a high-capacity arthroscopic battery according to the present invention, and symbol 39 represents an LCD-view window according to the present invention.

III. Practal Analysis and Implement

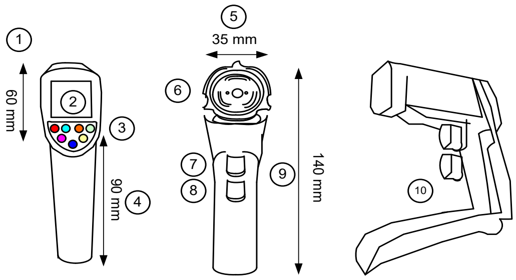
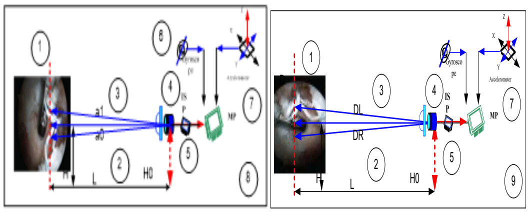
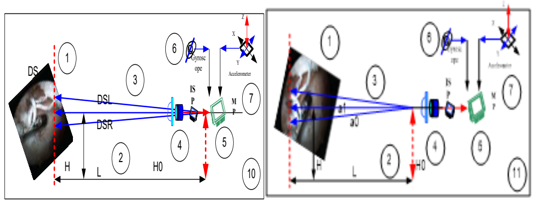


Figure 3 shows the handgun type of the present invention, where symbol 1 represents the approximate size of the integrated VIEW WINDOW, symbol 2 represents the LCD VIEW WINDOW, symbol 3 represents various CONTROL buttons, symbol 5 represents the width of the arthroscope VIEW window, symbol 6 represents the arthroscope VIEW window and the connection jack, symbol 7 represents the ZOOM-IN button of the arthroscope screen, and symbol 8 represents the button representing the ZOOM-OUT function of the arthroscope screen. Symbol 9 represents the handle length of the handgun wireless arthroscope, and symbol 10 represents the battery insertion space of the wireless arthroscope.



a) b)



c) d)

Fig.4 ,This study also uses a MEMS vibrating gyroscope. It measures the rotational speed as it rotates forward, backward, left, right, and up and down, consistently indicating a reference value.
Measuring the rotational angular speed allows for compensation by the same amount, ensuring the image displayed on the display remains horizontal even during rotation. Attitude control through compensation is a key application of gyroscopes.
Three-dimensional compensation requires a gyroscope for each axis of rotation. A high-precision gyroscope, along with an accelerometer

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Volume 5, Issue 5, Sep.-Oct., 2025, pp: 589-599 ISSN: 3048-6874
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measuring linear acceleration, integrates the acceleration measured in a three-axis reference frame to obtain velocity, distance, and position for navigation purposes.This device also uses a MEMS gyro sensor. Most gyro sensors utilize the Coriolis force, utilizing a tuning fork. The gyro sensors used in small mobile devices are 100% MEMS. MEMS technology is superior in terms of size and cost. MEMS gyroscopes measure angles using the Coriolis force.The Coriolis force, also known as the Coriolis force, is a force exerted on a rotating object. Its strength is proportional to the object's speed and the direction of the force is perpendicular to the object's direction of motion.

Figure a) shows the application of angular velocity and gyroscope to distance, Figure b) shows the application of angular velocity and gyroscope to height, Figure c) shows the application of angular velocity and gyroscope to a horizontal screen, and Figure d) shows the application of angular velocity and gyroscope to a non-horizontal screen.

Symbol 1 represents the screen inside the arthroscope, Symbol 2 represents length, Symbol 3 represents length as viewed from the left, Symbol 4 represents the lens, Symbol 5 represents the image signal processor, Symbol 6 represents the gyroscope sensor, and Symbol 7 represents the accelerometer.

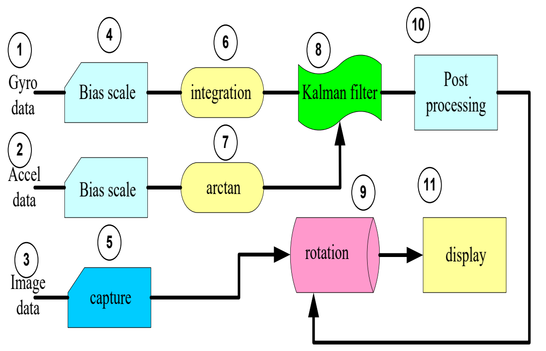

Figure 5 Image position correction using Kalman filter.

To represent spatial position, methods used include quaternions, direction cosine matrices, and Euler angles.To calculate the rotation angle of the endoscope with respect to gravity, an accelerometer and gyro sensor were attached to the endoscope handle to obtain acceleration and angular velocity. Euler angles were then calculated to determine the rotation angle.

The sensors used were the 3-Space Sensor Bluetooth (Yost Engineering Inc, Portsmouth, United States), which includes a 3-axis accelerometer, a 3-axis gyro, and a 3-axis geomagnetic sensor.

The measurements from the two inertial sensors were calibrated using a Kalman filter to determine the final rotation angle. The resulting Kalman filtered data was then postprocessed to compensate for the velocity difference between the image acquisition device and the sensor device.

A computer program that uses measurements from accelerometer and gyro sensors to determine the rotation angle of the endoscope and then rotates the endoscope image in real time and displays it on a monitor was developed using Microsoft Visual Studio for the Windows operating system.

Sensor values were repeatedly measured at maximum speed using a polling technique, and video images were captured at 30 frames per second. In this invention, we developed a device utilizing accelerometers and gyro sensors to improve the gravity direction correction of images acquired from video endoscopes.

The results of this study showed that, in the case of wireless connections, the integration error of the gyro sensor accumulates over time, leading to inaccurate values. However, this issue can be resolved with the use of a fast wireless sensor.

The image correction method proposed in this invention can be implemented at a very low cost, and accuracy is improved when both the accelerometer and gyro sensors are used together, compared to when using a single sensor. Symbol 1 represents gyro data, symbol 2 represents accelero data, symbol 3 represents image data, symbol 4 represents bias scale, symbol 5 represents capture, symbol 6 represents integration, symbol 7 represents arctan, symbol 8 represents kalman filter, symbol 9 represents rotation, symbol 10 represents post processing, and symbol 11 represents display.

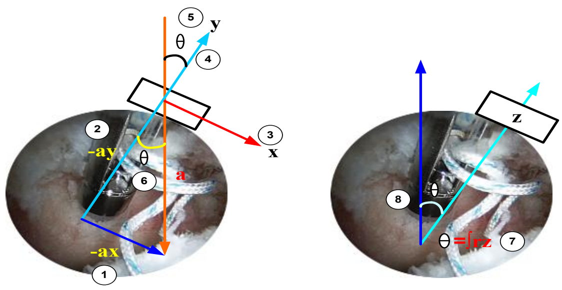

Figure 6 Image position correction at rotation angle using a sensor.Magnetic field sensors have the disadvantage of being sensitive to environmental factors due to their measurement units being micro-

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Tesla (uT), and require frequent calibration to obtain accurate measurements.

The present invention utilizes an acceleration sensor that measures changes in velocity, which in turn indicates changes in distance traveled, allowing for the calculation of distance traveled per unit time.Acceleration sensors do not solely measure movement; because gravity is involved, acceleration must be taken into account for movement.A gyro sensor measures the average angular acceleration per unit time. It displays different values depending on the control axis, using three orthogonal axes as control axes. This is widely used for attitude correction in moving objects such as airplanes.

In the axis and rotation angle of the inertial sensor attached to the endoscope, symbol 1 represents -ax, symbol 2 represents -ay, symbol 3 represents the x-axis, symbol 4 represents the y-axis, symbol 5 represents the angle θ, symbol 6 represents the weight axis angle θ, symbol 7 represents θ=integral rz, and symbol 8 represents the external axis of θ.It must be capable of continuous, real-time arthroscopic measurement, display on an Or-wall monitor and view window for arthroscopic feedback, support IPv6 in preparation for the IoT era, connectto the Internet to build an arthroscopic information database, process large amounts of data, be portable

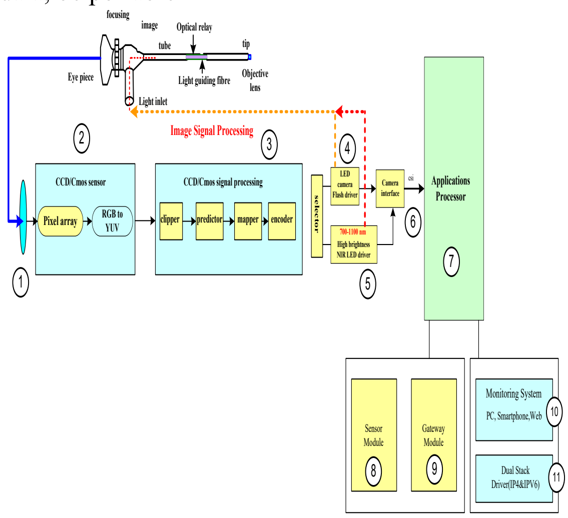

Figure 7. Hardware system of wireless arthroscope in Bluetooth image processing..

, easy to use, and consume little power.A real-time arthroscopic system consists of hardware and software. The hardware section consists of a sensor module and a gateway module.

The software section consists of a monitoring system and a driver. The monitoring system is available in PC, smartphone, and web versions. Symbol 1 represents the lens of the arthroscope, symbol 2 represents the CCD cmos sensor, symbol 3 represents the CCD cmos signal processing, symbol 4 represents the LED camera flash driver, symbol 5 represents the NIR LED driver with a wavelength of 700-1,100 nm, symbol 6 represents the camera interface, symbol 7 represents the application processor, symbol 8 represents the sensor module, symbol 9 represents the gateway module, symbol 10 represents the monitoring system, and symbol 11 represents the dual stack driver.

IV.Experiment Results

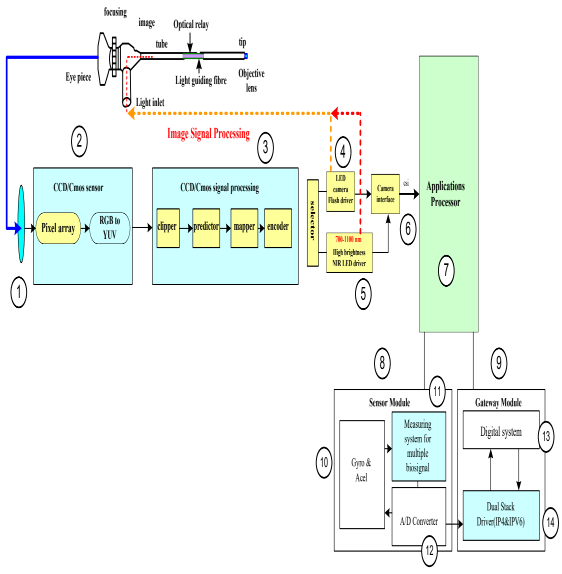

Figure 8. Wireless arthroscope sensor and gateway module in Bluetooth image processing..

The hardware component is largely divided into a sensor module and a gateway module. The sensor module consists of a sensor block and a control and communication block, as shown in Figure 8.

The sensor block receives measured signals, and the control and communication block digitizes the analog signals received from the sensor block and transmits them to the operating room wall monitor, smartphone, or gateway via Bluetooth or UWB communication.The gateway module connects the received biosignals to the Internet using IPv4 or IPv6-based TCP/IP communication.

The sensor module consists of a gyro sensor block, an accelerometer sensor block, and a geomagnetic sensor block. Symbol 1 is the arthroscope lens,

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symbol 2 is the CCD cmos sensor, symbol 3 is the CCD cmos signal processing, symbol 4 is the LED camera driver, symbol 5 is the 700~1,100nm high brightness NIR LED driver, symbol 6 is the camera interface, symbol 7 is the application processor, symbol 8 is the sensor module, symbol 9 is the gateway module, symbol 10 is the gyro & accel sensor, symbol 11 is the measuring system, symbol 12 is the A/D converter, symbol 13 is the digital system, and symbol 14 is the dual stack driver.

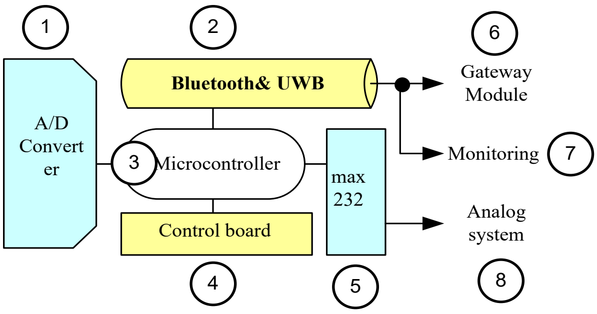

Figure 9 Control and communication module of the wireless arthroscope.

The configuration of the wireless arthroscopy control and communication module is shown in Figure 9. The microcontroller used is an MSP430 (TI). The MSP430 has a built-in 6-channel 12-bit ADC. Three of these channels were used to drive the gyro, accelerometer, and geomagnetic sensors, each converting to 512 Hz 12-bit data.

Meanwhile, the communication module used an FB155BC (Firmtech) supporting Bluetooth V2.0 and UWB, and was connected to the MCU via an SPI interface.

Symbol 1 represents the A/D converter, Symbol 2 represents Bluetooth (UWB), Symbol 3 represents the microprocessor, Symbol 4 represents the control board, Symbol 5 represents the MAX232, Symbol 6 represents the gateway module, Symbol 7 represents monitoring, and Symbol 8 represents the analog system connection interface.

V. Discussions

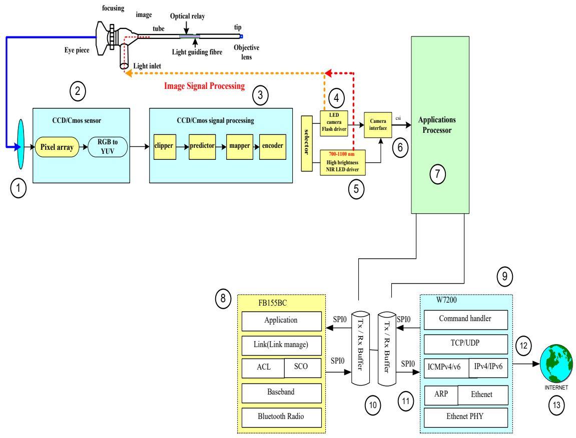

Figure 10 Wireless arthroscopy with simple image processing using gateway module.

The protocol structure for transmitting video signals over the Internet using an image processing gateway module is shown in Figure 10. Information received through the Bluetooth module is interfaced to the Internet via the TCP/IP protocol. Bluetooth was implemented using the FB155BC chip described above, and the TCP/IP protocol stack was implemented using the W7200 (Wiznet, Korea) chip.Symbol 1 represents the arthroscope lens, symbol 2 represents the CCD CMOS sensor, symbol 3 represents the CCD CMOS signal processing, symbol 4 represents the LED camera driver, symbol 5 represents the 700-1,100nm high-brightness NIR LED driver, symbol 6 represents the camera interface, symbol 7 represents the application processor, symbol 8 represents the Bluetooth FB155BC, symbol 9 represents the W7200 protocol stack, symbol 10 represents the TX/RX buffer, symbol 11 represents the TX/RX buffer, symbol 12 represents the protocol stack, and symbol 13 represents the Internet.

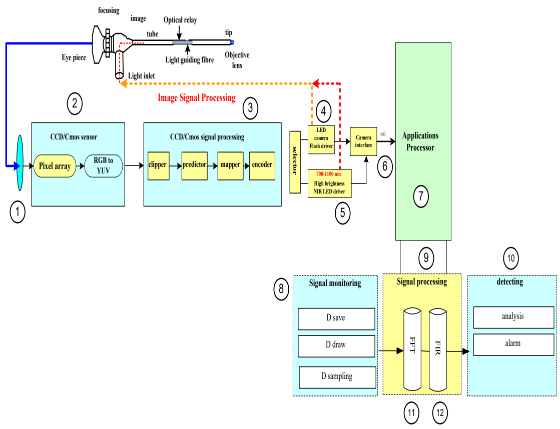

Figure 11 Monitoring program and operating program of wireless arthroscope.

The software consists of a monitoring program and a driver program. The monitoring program is implemented in PC, smartphone, and web versions. The PC version's monitoring program structure is shown in Figure 11. Data transmitted from a single channel consists of 12-bit data and 4-bit channel information. The channel information is used to distinguish the image signal. This image information is stored in the Signal Monitoring module and displayed as an image.To analyze the image signal, the Signal Processing module transforms and filters it through the Fast Fourier Transform (FFT) and Finite Impulse Response (FIR) processes.The FFT module converts time-series data into the frequency domain, while the FIR module, a digital filter, enables real-time processing of biosignals. The PC version was developed using Visual Studio 2010 (Microsoft).

The smartphone version performs similar functions to the PC version, but due to limited resources, it does not store image signals. Furthermore, due to resource constraints, the real-time FFT function is excluded. The smartphone version supports Android Ver. 2.3.4 environment, and the smartphone used was HTC's Sensation XE model.

Symbol 1 is the arthroscope lens, symbol 2 is the CCD CMOS sensor, symbol 3 is the CCD CMOS signal processing, symbol 4 is the LED camera driver, symbol 5 is the 700~1,100nm high brightness NIR LED driver, symbol 6 is the camera interface, symbol 7 is the application processor, symbol 8 is the signal monitoring, symbol 9 is the signal processing, symbol 10 is the detecting, symbol 11 is the FFT, and symbol 12 is the FIR function.

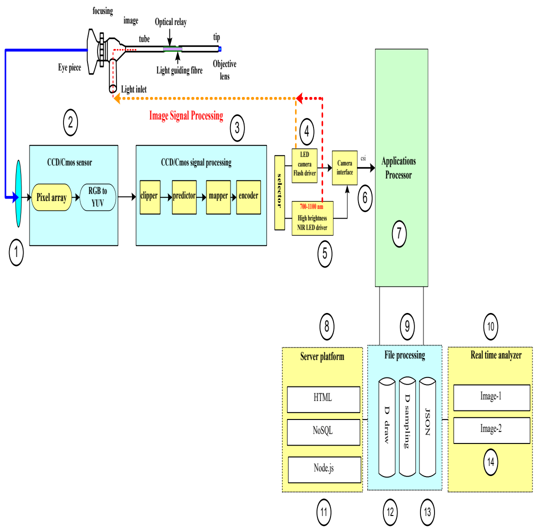

Figure 12 Web version monitoring program for wireless arthroscopy.

The web version of the monitoring program structure is shown in Figure 12. The server platform was built using Node.js, NoSQL, and HTML5.0.

To store large amounts of data, the database server used Node.js, an event-driven distributed web server. MongoDB, a DBMS for handling unstructured relational databases, was used.

File processing was implemented using JSON (JavaScript Object Notation), Data Sampling, and Data Draw. The data processing method used JSON, and the screen display was updated once per second. Finally, a function was implemented to calculate abnormal image quality using the collected image signals and to issue an alarm if an image problem occurs.Connecting the real-time image signal measurement device to the Internet required a TCP/IP protocol stack including IPv4 and IPv6. As previously described, this was implemented using Wiznet's W7200 chip. A driver program is required for the initialization process, auto-configuration, and mode setting functions. The driver program's initialization process includes address registration, SPI interface initialization, and hardware reset.Auto-configuration for IPv4 and IPv6 first checks whether the device is in an IPv6 environment. If not, it operates in an IPv4 environment by default. If it is in an IPv6 environment, it checks whether it has been manually configured or automatically assigned. If it is set to automatic, it performs the IPv6 auto-configuration process and assigns an IPv6 address.Meanwhile, for TCP/IP communication, the W7200 module must determine whether to operate in UDP mode, TCP server mode, or client mode. In UDP mode, it opens a socket, determines whether to send or receive, and performs the corresponding UDP function.

TCP server mode opens a socket, waits for a SYN message from the client, and responds to it through a three-way handshaking process to establish a connection and exchange data. TCP Client mode opens a socket, sends a SYN message to the server, receives a response, establishes a connection, and then sends and receives data. Symbol 1 represents the arthroscope lens, symbol 2 represents the CCD CMOS sensor, symbol 3 represents the CCD CMOS signal processing, symbol 4 represents the LED camera driver, symbol 5 represents the 700-1,100nm high-brightness NIR LED driver, symbol 6 represents the camera interface, symbol 7 represents the application processor, symbol 8 represents the server platform, symbol 9 represents file processing, and symbol 10 represents the real-time analyzer function.

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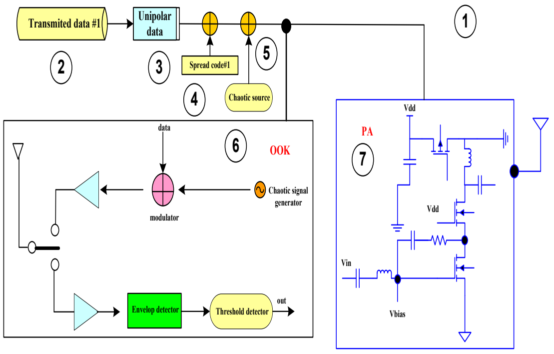

Figure 13 UWB (Bluetooth) transmission processing in arthroscopic images.

The UWB system transmits binary data carrier-free using impulses. To transmit large amounts of information, it uses a pulse train structure that generates pulses continuously, rather than the single pulses used in radar.

UWB-based communication technology and channel modeling applicable to endoscopes include ultra-wideband modulation and demodulation using chaotic sources and chirp signals. Chaotic UWB uses a chaotic source as a carrier and multiplexes codes based on On-Off Keying (OOK) modulation, allowing for extremely simple carrier signal generation. The receiver structure, like the transmitter, can be simplified, making it ideal for WBANs, which require accurate transmission of low-speed data.A chaotic source is a random signal, similar to white noise. Incorporating a chaotic source into a system allows for the easy implementation of a carrier source with ultra-wideband (UWB) characteristics. When combined with the OOK modulation scheme, the envelope detection receiver architecture can help achieve the simple hardware implementation and low power consumption desired in WBAN systems.

Basically, the load stage is configured with an R-L resonator. Inductors are inserted at the cascode input and output to increase the gain in the upper band. A transistor is added in parallel to the first transistor of the cascode stage to compensate for the reduced gain in the lower band. A resistor is inserted between the body and source of the cascode stage transistor to ensure a low noise figure across the entire bandwidth.

Symbol 1 represents the entire receiver, symbol 2 represents the transmitted data, symbol 3 represents the unipolar data, symbol 4 represents the spread code, symbol 5 represents the chaotic source, symbol 6 represents QQK modulation, and symbol 7 represents the PA.

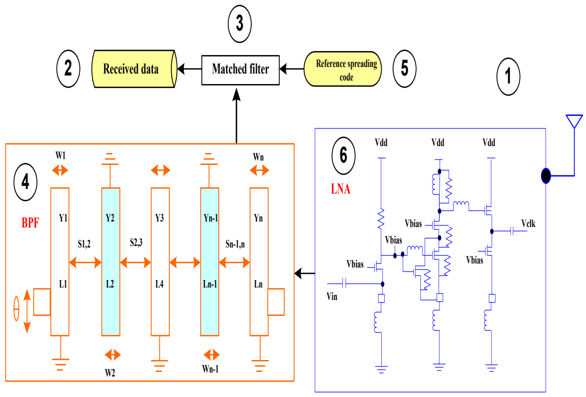

Figure 14 Wireless arthroscope receiving UWB (Bluetooth) in arthroscopic images.

UWB systems detect signals by receiving energy distributed across a wideband, making them resistant to interference from narrowband communication signals. This signal would otherwise appear as noise in conventional narrowband communication systems, making them ideal for secure communications.

Ultra-high data rates are possible. By extracting signals from the energy distributed across the wideband, processing gain increases inversely proportional to the duty cycle, resulting in high processing gain. This high processing gain enables ultra-high-speed data transmission.

UWB systems have a transmission rate of 100 Mbps. In the frequency domain, the power spectrum is concentrated within a specific frequency band. While generating short, high-power pulses, their extremely narrow width effectively disperses the energy across a wide bandwidth, resulting in very low spectral power density.Its average power is 1/100th that of mobile phones or WLANs, and it is a type of baseband communication using encoding.Since the signal is transmitted as a carrier wave without frequency modulation using a carrier wave, linear amplifiers are not required unless high-power communication is required. Furthermore, since no intermediate frequency stage is used, the system structure is very simple.Utilizing time-division multiple access (TDMA), it enables wideband service for multiple users. Because the signal is distributed over a wide bandwidth, it is suitable for short-range communication and is therefore suitable for medical devices.Symbol 1 represents the UWB reception concept, symbol 2 represents the receiver, symbol 3 represents the matched filter, symbol 4 represents the band push filter, symbol 5

International Journal of Humanities Social Science and Management (IJHSSM)
Volume 5, Issue 5, Sep.-Oct., 2025, pp: 589-599 ISSN: 3048-6874
www.ijhssm.org

represents the reference spreading code, and symbol 6 represents the LNA.

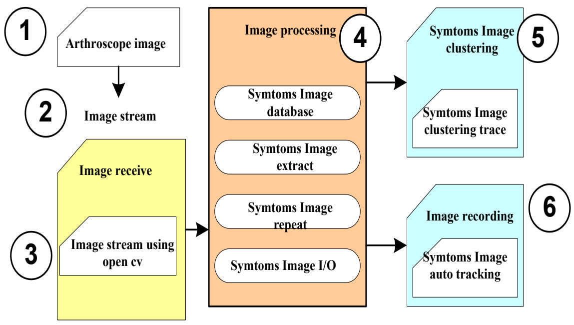

Figure 15 Real-time image monitoring in arthroscopic images.

This study not only tracks a single specific symptom, but also identifies the movements of various specific symptoms and clusters and tracks all abnormal symptoms. This system allows physicians who need to identify specific symptoms to identify and track all specific symptoms, which can easily go unnoticed by focusing on a single specific symptom or overlooking other areas.The image processing system for tracking specific symptoms implemented in the present invention comprises image stream transmission, image processing, specific symptom clustering, and image recording processes, as summarized below.It can be divided into a video monitoring image receiving unit, an image processing unit for tracking specific symptoms, a clustering unit for clustering multiple specific symptoms, and a recording unit for recording specific symptom tracking images.
The video monitoring image receiving unit stores images received from the endoscope camera in computer memory and passes the data to the image processing unit for real-time processing.
The image processing unit receives the incoming image frames in real-time, distinguishes between background images and specific symptom images, and applies an image processing algorithm to track the specific symptoms. The clustering unit, which clusters multiple specific symptoms, identifies all areas identified as specific symptoms, assigns numbers to them in order, and sorts them in memory. The clustering process then continues to track the specific symptoms until the abnormal movement of the specific symptoms ceases.The recording unit, which saves the movement of specific symptoms as a file, stores the video as a file on a computer when a doctor monitoring the video issues a recording command to analyze the current movement of the specific symptom in more detail, along with the video with the image processing algorithm applied. Symbol 1 represents arthroscope image, symbol 2 represents image stream, symbol 3 represents image receive, symbol 4 represents image processing, symbol 5 represents symptom image clustering, and symbol 6 represents image recording.

VI.Conclusion

This handgun-style endoscopic device features spectral analysis, position correction, and a viewing window. Its convenient structure includes an endoscope connector, universal cord, control section, and insertion tube.
When used as a general light source, it is driven by an ultra-wide-angle lens, an image sensor, and an LED. Near-infrared spectral analysis with a short wavelength of 700-1,100 nm LED allows for the selection of filters that differentiate the contrast between lesions and normal tissue, enabling colorized infrared expression. Spectral analysis of the affected area facilitates differentiation between abnormal and normal tissue. The near-infrared wavelength range allows for easy filter replacement, and the convenient jack-type design allows for convenient positioning.
Position correction utilizes an accelerometer and gyro sensor to ensure that the gravitational direction of the endoscopic image is always aligned with the designated position. Using the acquired image, the device can detect abnormal areas and easily monitor the progression of the affected area. Using arthroscopic images, the video endoscope's image correction device receives data from a gyro sensor attached to the endoscope's handgun, facilitating Kalman filtering and post-processing.
A large image monitoring and viewing window is attached to the main unit, allowing medical staff to conveniently view the data on a small LCD screen directly attached to the arthroscope during surgery. This allows for real-time dual display. Detected images of specific symptoms are automatically saved and stored in a database for analysis, facilitating wireless video communication.
A wireless communication system was established, combining a digital electronic camera module with a UWB communication module that transmits high-quality image information sensed by the endoscope. This UWB-based communication is then used between the transmitter and the monitor.

Acknowledgements “It was supported as an industry-academia joint technology development

project of the 2025 RISE."

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