Design for a Self-contained, Maneuverable Endoscopic Video Camera

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Function: Design a self-contained, maneuverable endoscopic video camera system that can be set in place and be maintained internally for post-operative viewing. This device would allow a veterinarian to periodically monitor a patient, thus reducing the number of invasive procedures. The client works with small animals at the UW Veterinary Hospital where he currently uses a rigid scope with an attached camera head and a Xenon light source to conduct surgery. At the present time, no device allows for non-invasive post-operative viewing of the abdominal cavity. We are interested in exploring the possibilities of designing an endoscopic camera that can be deftly orientated without compromising the visual capacity of the video camera.

Client requirements: The device must:

- be able to be completely gas sterilized.
- be able to be used both during and following a surgical procedure.
- be built within a $500 budget.
- be able to capture images comparable to current laparoscopes.
- contain its own light and power sources.
- be able to store data internally, or transmit the data wirelessly.
- be easily removable from the patient.

Design requirements:

1. Physical and Operational Characteristics

    a. Performance Requirements
        i. Must be able to function within a biological environment
        ii. Camera's viewing field must be able to be clear during imaging
        iii. Must maintain its position in the body for multiple days
        iv. Must be an improvement to the current operative viewing procedures
        v. Must be able to transmit data from camera to an outside storage device
        vi. Must possess the ability to illuminate the abdominal cavity during imaging

    b. Safety
        i. No sharp edges or protrusions that may cause abrasions to surrounding tissue
        ii. Maintain its location throughout its entire stay in the body
        iii. Efficient and practical method of insertion and extraction
        iv. Mechanically and biochemically resistant materials to minimize debris *in vivo*
        v. Must be easy to sterilize prior to insertion into body

c. Accuracy and Reliability
    i. Visual information must be transmitted post-operatively when camera activated
    ii. Visual resolution must be on par or exceed that of current endoscopic cameras
    iii. Method of maintaining a clear viewing field is imperative
    iv. Stable construct that can remain intact and functional throughout duration *in vivo*

d. Life in Service
    i. Camera must be used multiple times post-operatively
    ii. Battery must last for at least one week before recharging
    iii. Camera navigation system must be continuously operable

e. Operating Environment
    i. *In vivo* conditions apply within abdominal cavity
    ii. Constant temperature, pressure and humidity maintained
    iii. Biochemical interactions make for hostile environment conditions
    iv. Compression force on camera by organs when patient is mobile, post-surgery

f. Ergonomics
    i. Must be easy for doctor to place camera in patient's body before viewing period
    ii. Must be able to be positioned in the patient's body securely so that it will not be errantly moved from its initial location (i.e. without the assistance of the veterinarian)
    iii. Must be easy for doctor to locate the device and remove from the patient's body following the viewing period

g. Size
    i. Maximum size for the portion of the device located inside the patient's body is 10-25 mm in diameter
    ii. Once placed in the patient's body, the device cannot cause damage to any of the patient's surrounding organs or tissues

h. Weight
    i. Must weigh enough to be able to be securely fastened to the patient's body
    ii. Also must not weigh too much to cause pain to patient after placement, or have the potential to disconnect from the coupling device used to secure the device in place
    ii. *Maximum weight*: 1-2 lbs

j. Materials
    i. Must be able to remain within the body for several days
    ii. Must be completely waterproof to protect patients from electrical components

iii. Electrical components must be tolerant of large magnetic fields

k. Aesthetics, Appearance, and Finish
- i. Final unit must be small enough to fit through a standard surgical trocar
- ii. Outer cover must not have any sharp edges that could puncture or otherwise damage the patient
- iii. The outer cover portion that the lens faces must be transparent enough to obtain a clear picture under a low-light setting
- iv. The magnetic control device that is utilized outside of the patient must be easy to use and adjust during viewing sessions
- v. Camera unit should be easy to insert, fix into place, and remove with little complication

2. Miscellaneous:

a. Standards and Specifications:

The device must:
- i. Be approved for experimental animal surgery
- ii. Undergo several tests and clinical trials before being approved by the FDA for human use

b. Customer (Doctor):
- i. Would like a device that is easy to insert, use, and remove
- ii. Wants a device capable of maintaining a clean lens
- iii. Wants the device to provide sufficient light for optimum viewing
- iv. Wants the device to improve both surgical and post-operative viewing procedures

c. Patient-Related Concerns:

The device must:
- i. Be able to be gas-sterilized between patients
- ii. Limit patient discomfort while *in vivo*
- iii. Not hinder the patient's daily activities
- iv. Remain attached to patient during observation period
- v. Be easy to remove from patient post-observation

d. Competition:
- i. Pill Cam™ (ESO, SB, COLON)
- ii. Steerable segmented endoscope (US Patent 7087013)
- iii. Rigid endoscope
- iv. Wireless endoscopic camera (WO/2008/063565)
- v. Fiber optic endoscope
- vi. Deflectable endoscope (US Patent 5168864)
- vii. HeartLander (A Miniature Cable-Driven Robot for Crawling on the Heart) - CMU