Low Resource Bronchoscope

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Project Overview - Current Need

According to a Lancet review article published in 2010, there is an increasing demand for healthcare services in low-income countries.

1. Geopolitical reasons: natural and manmade disasters
2. Scarcity of resources
3. Burden of illness exceeding existing healthcare capacity

Role of Bronchoscopes

Burden of TB is highest in low-resource areas

- 10.6 million people in 2016 in which 1 million were children

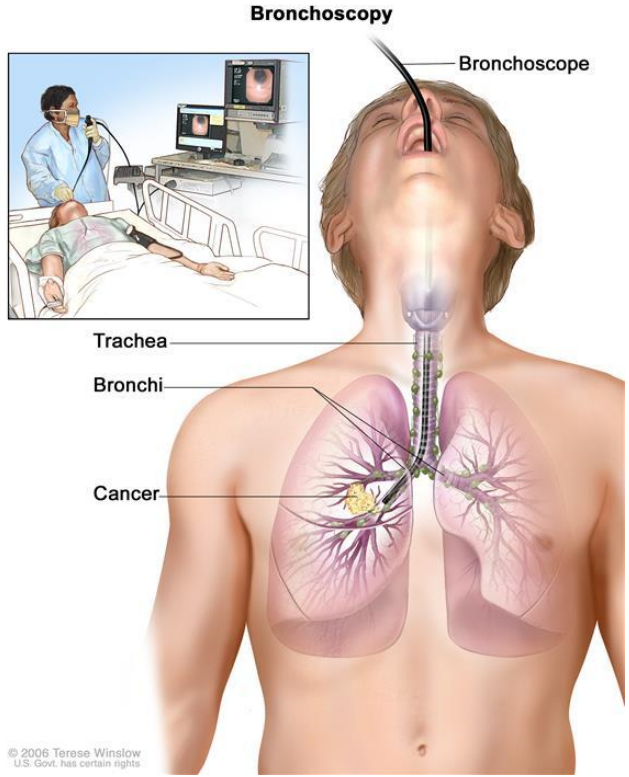
Diagnosis through sputum sample but more often bronchoscopy to diagnose this condition and to determine if surgery or medication is required

Also possibly utilized in treatment of COPD and asthma

What is a Bronchoscope

General

- A thin, tube-like instrument with a light and lens for viewing
- Inserted through the mouth, trachea, and major bronchi into the lung



Current Market

Valued at roughly 12.4 million USD and expected to double in 7 years

- High barrier to entry

2 Major Players in the reusable bronchoscope field

1. Olympus - high baseline cost: 7,000-15,000 USD
2. Pentax - lower base cost: 4,000 USD

- Cleaning costs between 100 and 300 USD

Reusable vs Single Use probes

- Single use probes are easier to use
- Reusable probes have lower cost per procedure

Problem Statement

We aim to design and develop a fiberoptic bronchoscope that is more cost efficient, portable, and durable than current devices on the market and can also be controlled with common appliances such as iPhone and iPad technology for universal ease of use and increased availability.

Needs Assessment

Functionality
- Match competitors' specifications as closely as possible
- Equipped with a companion application

Cost Reduction
- Materials and hardware shall be selected to reduce cost without large sacrifices to performance
- The device shall be reusable with a single use outer sheath to eliminate reprocessing
- Parts shall be durable and easily replaceable in case of failure

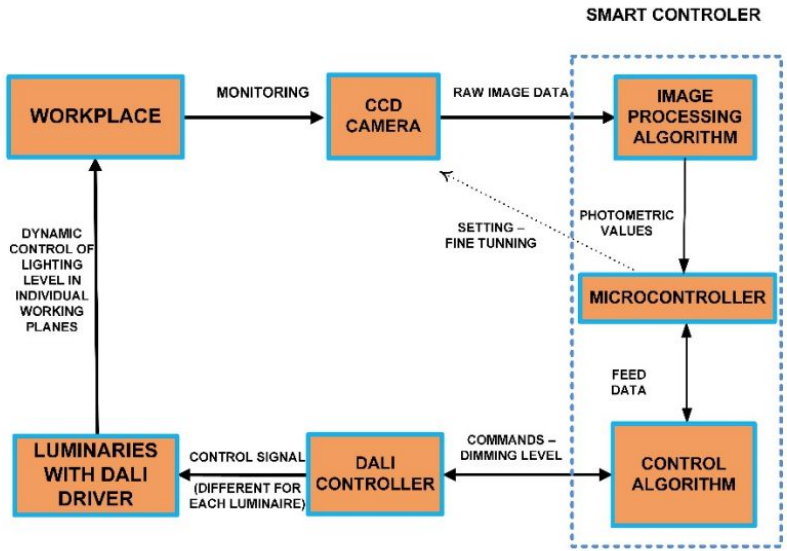
Ease of Use
- More intuitive control scheme than current bronchoscopes
- Integrated with a companion application for real-time video streaming

Portable
- Powered using single cell batteries
- Coiled to save space during transport

Durable
- Hardware shall be properly insulated
- Parts should be optimized for durability to lower replacement costs

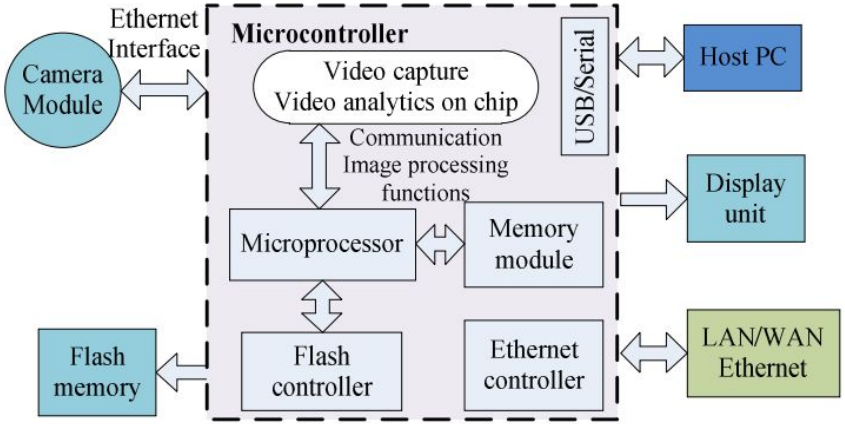
Electrical Design - Overview

- Microcontroller is external.
  - Eliminates the need for it to be connected to the handle.
- Two part process:
  - Camera → Microcontroller
    This processes the image
  - Microcontroller → User
    Encodes data with a control algorithm and broadcasts it back to the host.



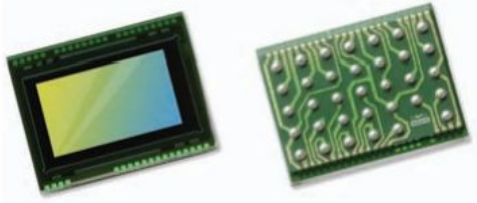
Electrical Design - Hardware

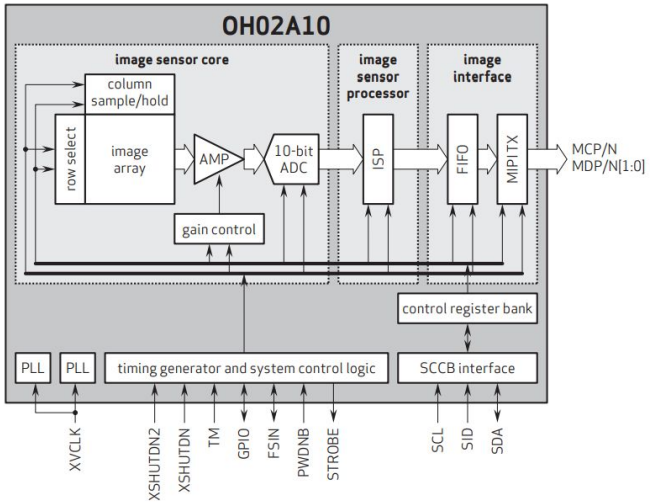
- CCD Camera - OH02A10
  - These cameras are frequently used for endoscopic purposes.
- Microcontroller - BeagleBone Black
  - 32-bit ARM-based microcontroller
  - Supports real-time communication.



Optical Design

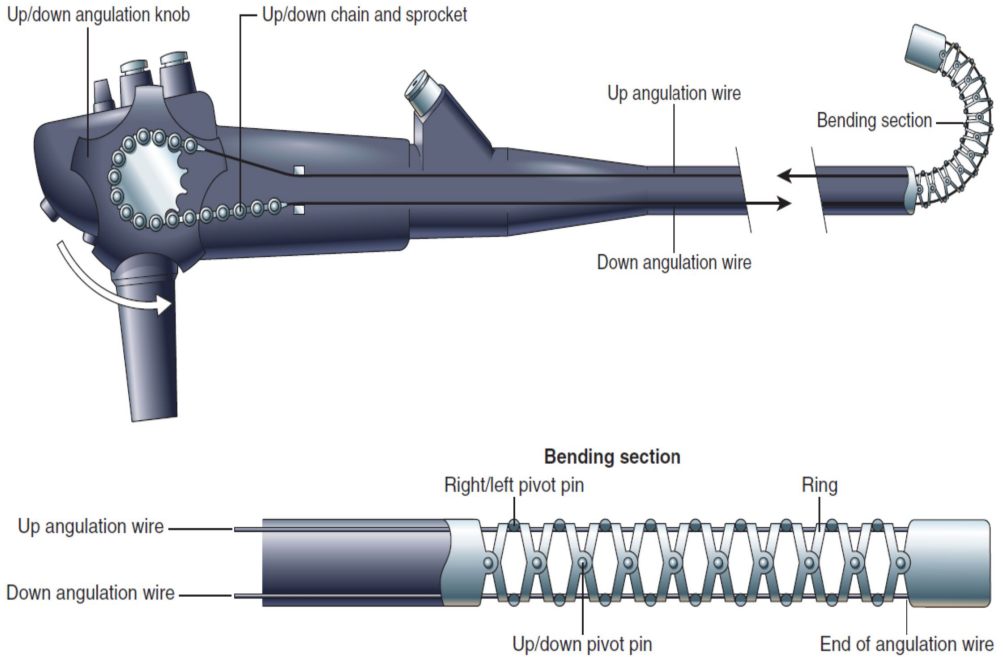
- OmniVision OH02A10
  - Commonly used in industrial and medical endoscopes
  - Affordable: $90
- Specifications
  - Small form factor:
    - 3.8 x 2.9 mm chip package
  - High quality imaging
    - 60 fps at 1080p resolution
    - 90 fps at 720p resolution
  - Low heat dissipation:
    - 90 mW when recording 60 fps 1080p
  - MIPI interface gives Arduino and Rasp Pi compatibility





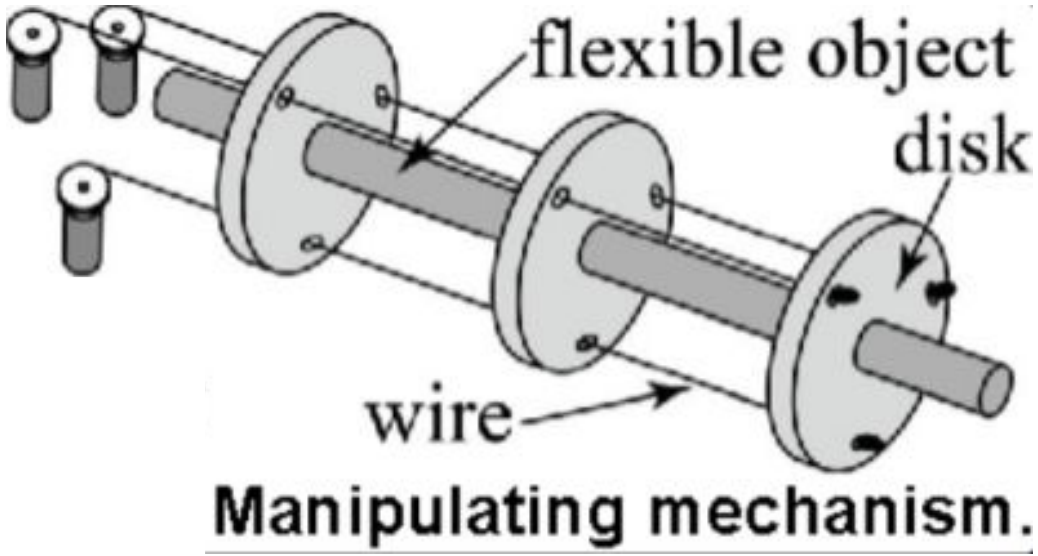
Mechanical Design - Option A

- Bending section consists of metal rings
  - Connected via freely moving joint made of pivot pins
- 2 sets of pivots
  - Up-down
  - Left-right
- Directional movement controlled by angulation wires
  - Wires connected by chain, moved by 2 knobs



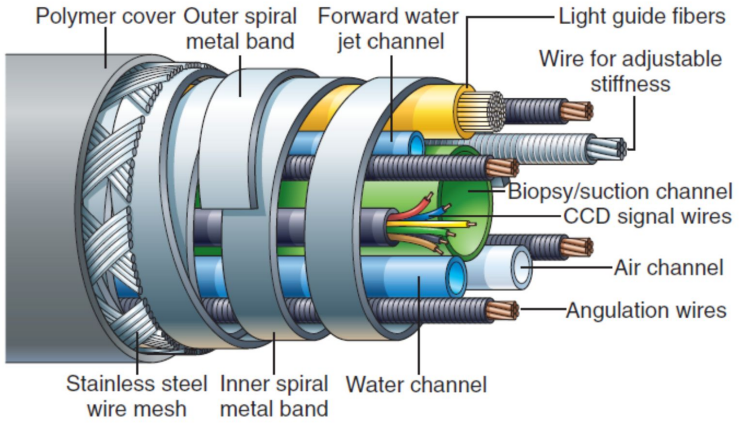
Mechanical Design - Option B

- Consists of wires threaded through disks
  - Wires wrapped around spools
  - Reeled in and out by knobs
- Simpler, cheaper design
  - Potentially plastic instead of metal
    - Easier to prototype
  - May reduce maneuverability and durability

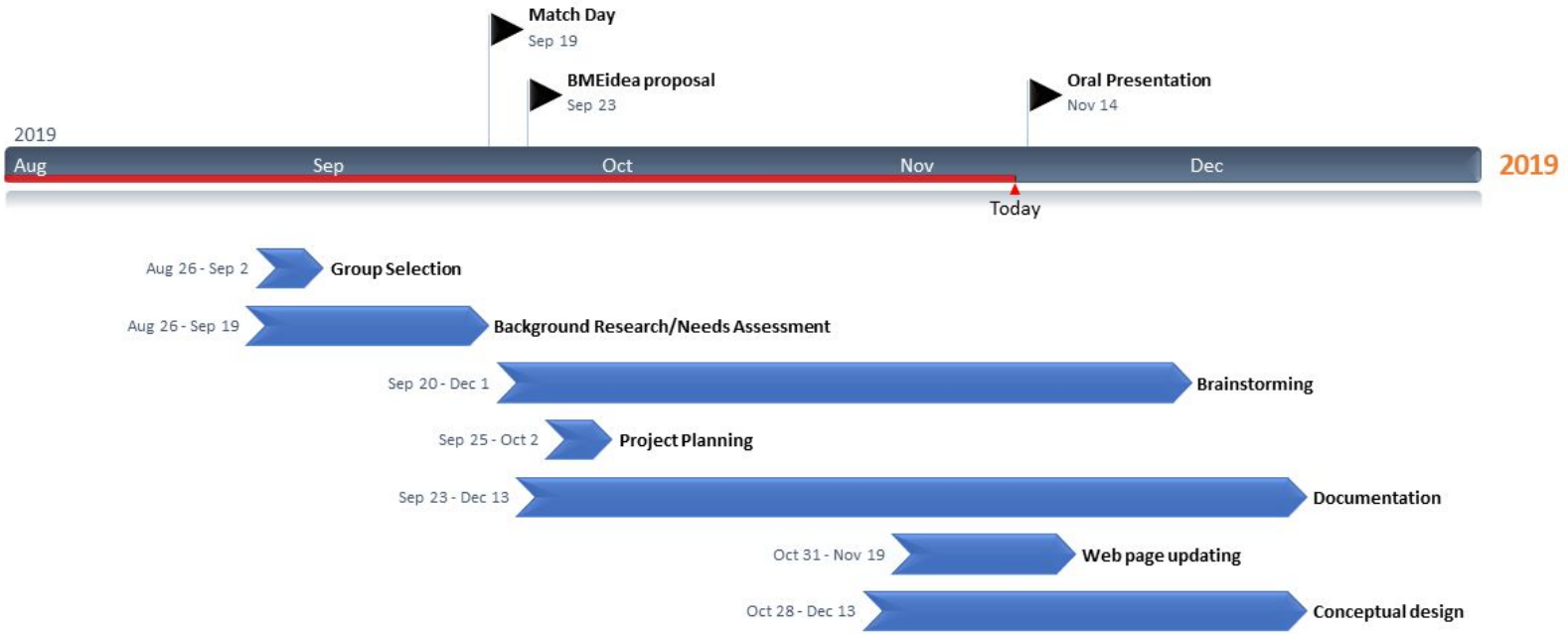


Channels and Wires

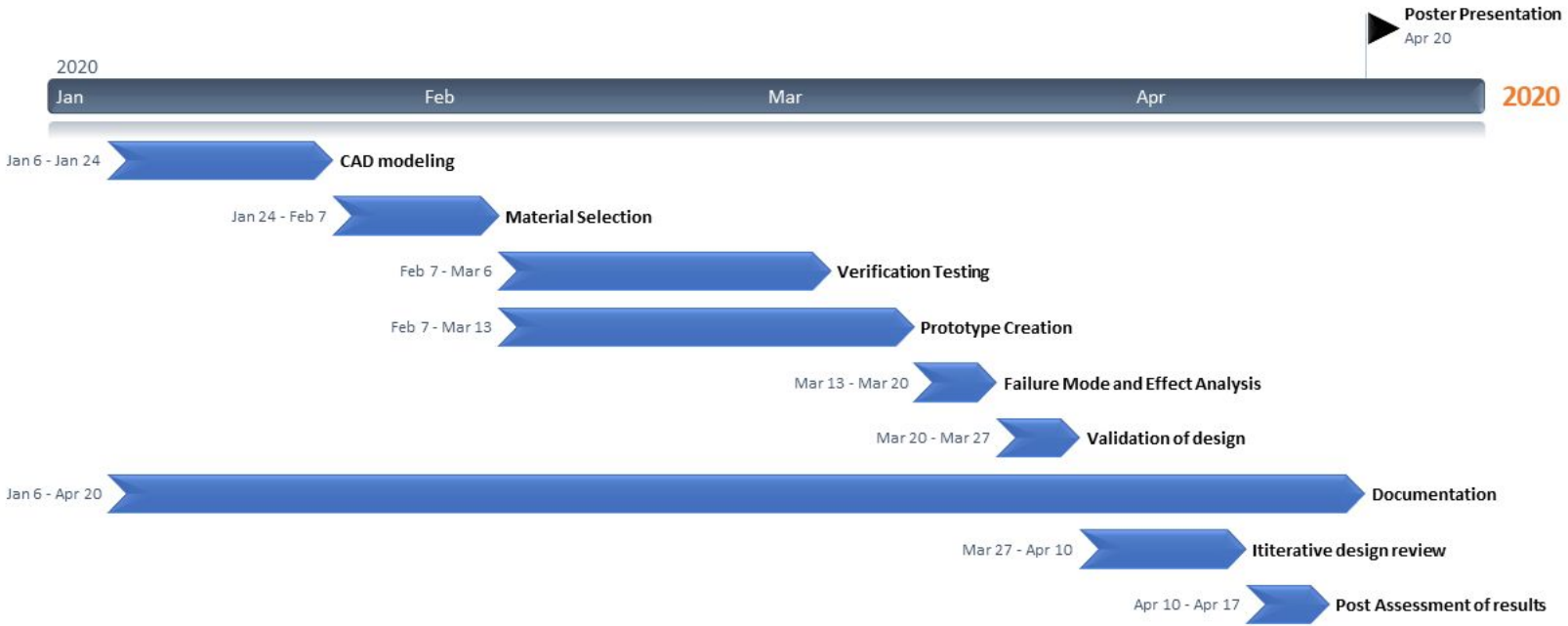
- Functionality vs. Simplicity
  - Need to determine cost and difficulty of expanding functions
- Design must accommodate
  - Angulation wires
  - Fiber optics
  - Camera wire
  - Biopsy/suction channel
    - Possible water/air channel



Project Plan



Future Design Path



Bill of Materials

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