Minimally Invasive Surgery

- Small incision
  - Low risk of infection
  - Short recovery time
- CO₂
  - Injected by needle
  - Integrated into instrument
- Uses
  - Exploratory surgery
  - Laparoscopic surgery
  - Arthroscopic surgery

Appendectomy

- Appendix
  - Attached to colon / large intestine
  - No known function
  - Inflamed
- Surgery
  - Removal
Hernia

- Hernia
  - Weakened abdominal wall (muscle)
  - Intestine protrudes through abdomen
  - Visible bulge
- Surgery
  - Retract intestine
  - Sew abdominal wall

Gallbladder

Stores bile produced by liver
Releases bile into digestive tract to emulsify fat
Reduced tolerance to high-fat foods after removal
Colon Resection

- Colon
  - Infected / inflamed
- Surgery
  - Affected section removed
  - Colon reconnected

Gastric Bypass

- Pouch made from top of stomach
- Small intestine sewn to pouch
- Most of stomach bypassed
Arthroscopic Knee Surgery

• Menisectomy
  – Remove or repair torn cartilage
• ACL Reconstruction (video)

Instruments

<table>
<thead>
<tr>
<th>Trocar</th>
<th>Laparoscope / Arthroscope</th>
<th>Forceps / Scissors</th>
<th>Stapler</th>
<th>Elevator / Retractor</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Trocar Image" /></td>
<td><img src="image2.png" alt="Laparoscope Image" /></td>
<td><img src="image3.png" alt="Forceps Image" /></td>
<td><img src="image4.png" alt="Stapler Image" /></td>
<td><img src="image5.png" alt="Elevator Image" /></td>
</tr>
</tbody>
</table>
**Instrument Types**

- **Trocar**
  - Apertures
  - Lengths

- **Staplers**
  - Straight
  - Helical
  - Circular

- **Retractors**
  - Expanding
  - Extending
  - Articulating

**Laparoscope**

[Diagram of a laparoscope with labels for Optical Fibres, Lens, Camera, and Light Source.]
Forceps / Scissors

- Transmissions
  - Rod
  - Cable / Cable
  - Cable / Spring

Cable Drives

Reduction ratio $\propto d$

Navigate Corners
Dextrous Tips

- Retract to change angle
- Spring loaded sleeve
- Drive cable
- Rotate to change direction
- Stiff housing
- Steerable (dextrous) sleeve
- Steering cable

Articulating MIS Tools
4-DOF Motion Range
(2 in reverse direction)

2-D Transformed Image

• Exercise
  – Start up Paint
  – Draw an “S”
  – Change the pen colour
  – Re-trace the “S”
## Difficulties with MIS

<table>
<thead>
<tr>
<th>Physical Constraints</th>
<th>Human Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motion</strong></td>
<td><strong>Lost</strong></td>
</tr>
<tr>
<td>- Restricted</td>
<td>- Depth perception</td>
</tr>
<tr>
<td>- Reversed</td>
<td>- Tactile perception</td>
</tr>
<tr>
<td>- Scaled by distance to incision</td>
<td>- Proprioception</td>
</tr>
<tr>
<td>- Fixed approach angle</td>
<td>- Visual navigation control</td>
</tr>
<tr>
<td>- Far from hands</td>
<td>- Peripheral vision</td>
</tr>
<tr>
<td><strong>Instrument</strong></td>
<td><strong>Altered</strong></td>
</tr>
<tr>
<td>- Backlash</td>
<td>- Visual transformation</td>
</tr>
<tr>
<td>- Flexibility</td>
<td>- Head position</td>
</tr>
<tr>
<td>- Size</td>
<td></td>
</tr>
<tr>
<td>- 1 per incision</td>
<td><strong>Communication</strong></td>
</tr>
</tbody>
</table>

- Visual transformation
- Head position
- Communication