

STRESS ANALYSIS ON A CAPSULE ROBOT DUE TO THE PERISTALTIC MOVEMENT OF THE INTESTINE

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Microbiota?



Microorganisms inside the gut



Gut contains 1-1.5 Kg of microbiota



Provides lifelong information of human attributes like health, mood, behaviour, etc.



Helpful in early diagnosis of diseases like cancer, obesity and diabetes



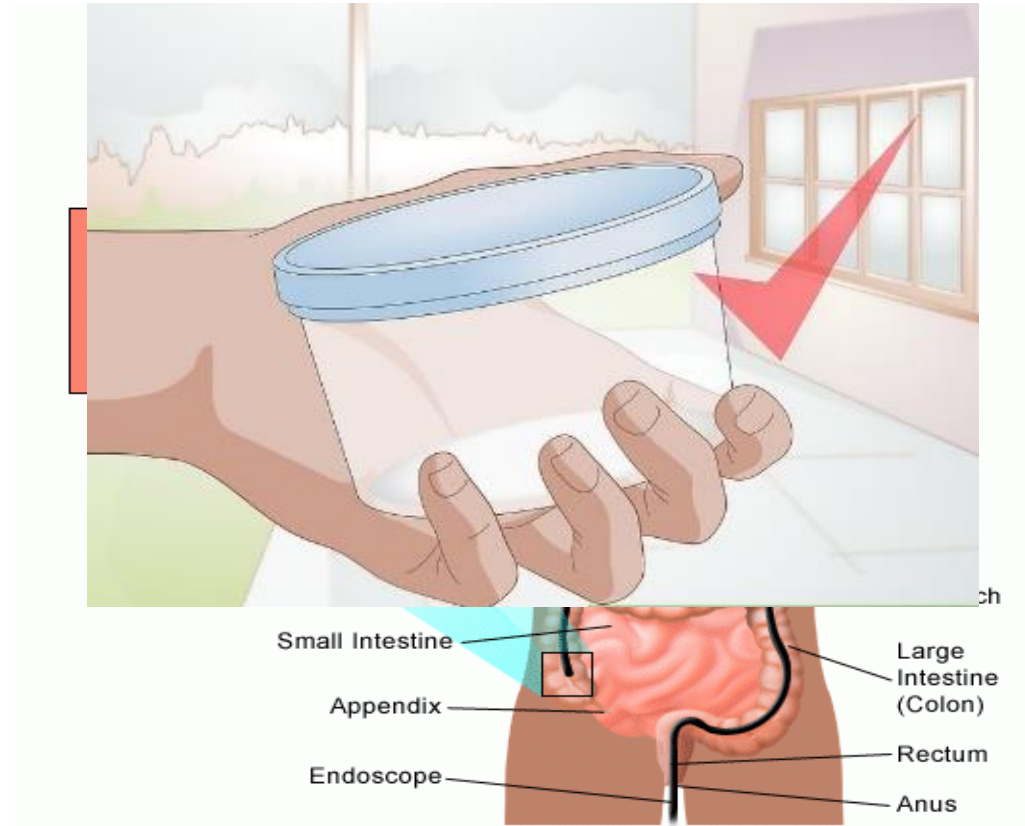
Traditional Sampling Methods

1. Faecal sampling

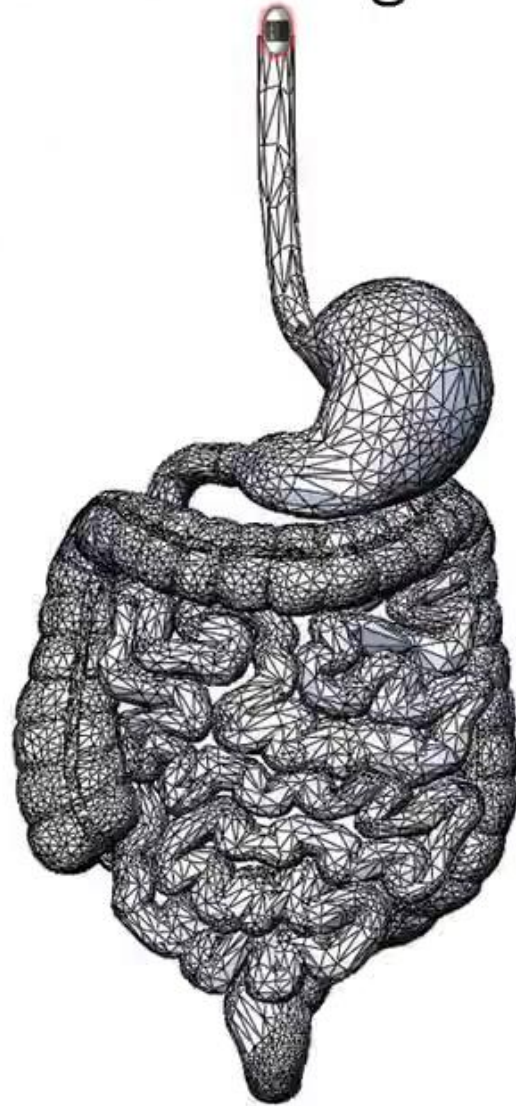
- Lacks spatial and temporal information
- Sample cannot be localized

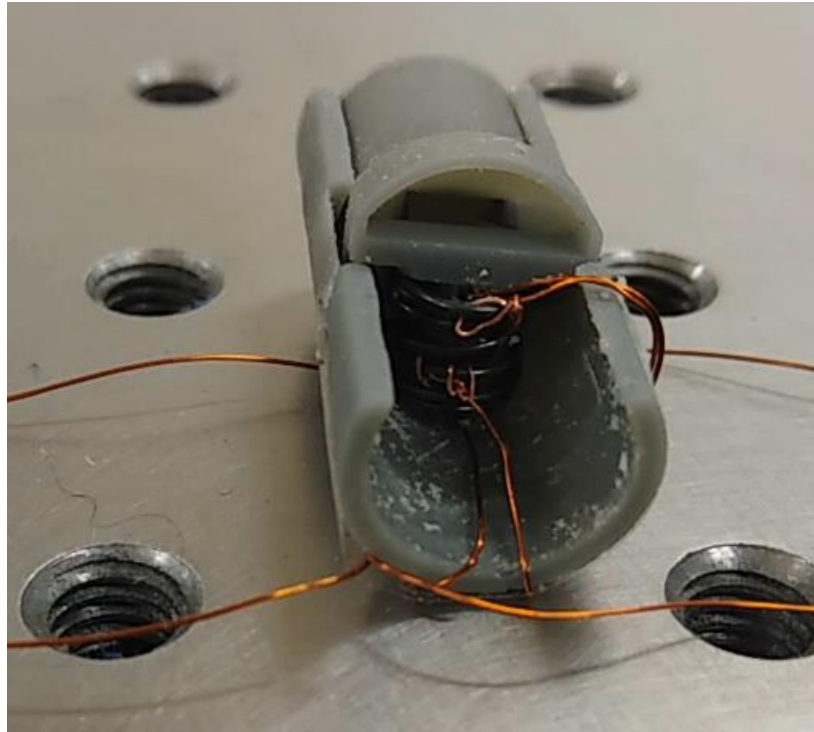
2. Tethered tools

- Cannot explore entire GI tract
- Cannot collect content



Capsule robot enters the gut through mouth

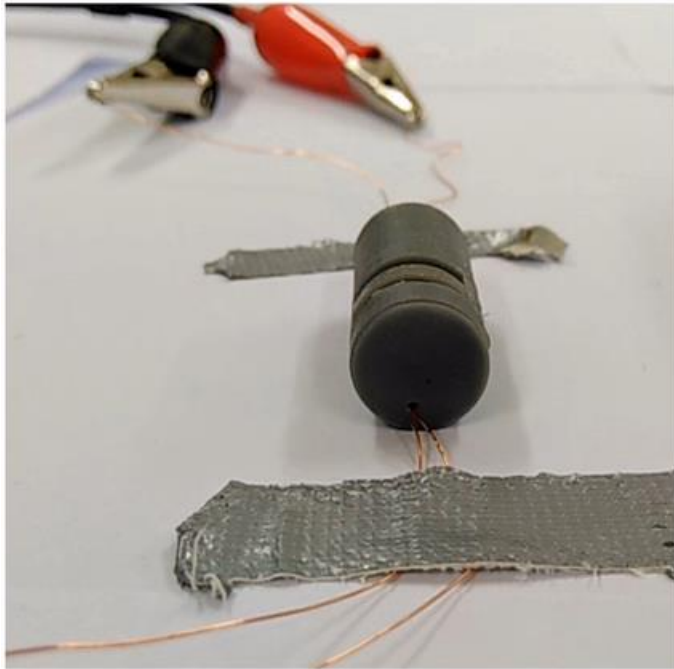




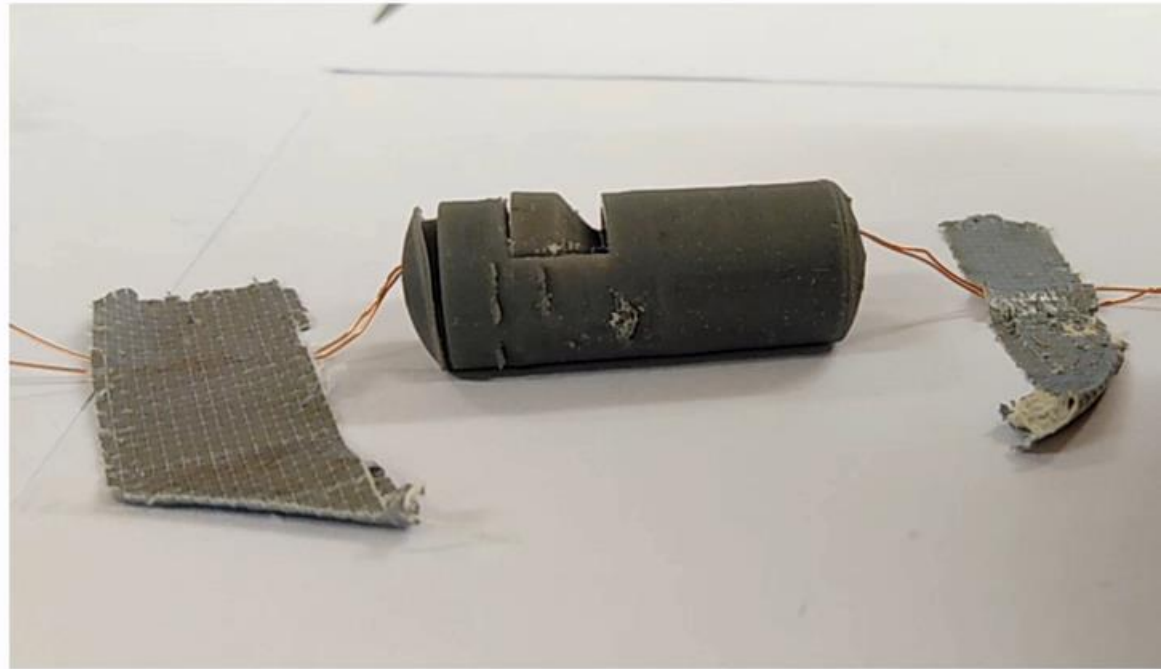
SPRING ACTUATOR OPENING



Front view



Side view



CAPSULE ROBOT





EXPERIMENTS ON ANIMAL INTESTINE



Challenges for *In-vivo* testing



Experiments were conducted on post-mortem tissue of animal intestine



Spring actuator needs to overcome the peristaltic force during *in-vivo* trials



Exact peristaltic forces are unknown

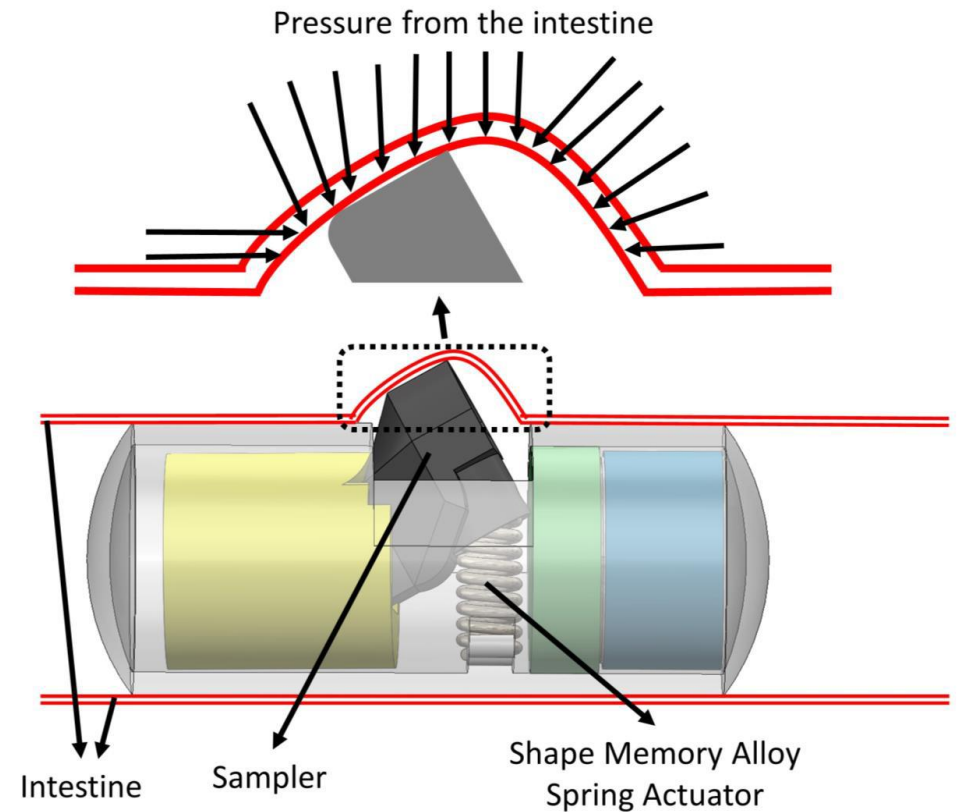


Direct testing in animals and/or humans would be dangerous



Modelling

- Model intestinal contraction forces
- Model spring actuator movement
- Study the interaction between intestine and sampler



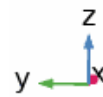
Modelling phases

1. Simulating peristaltic motion
2. Capsule movement inside the intestine
3. Studying the interaction between intestine and capsule

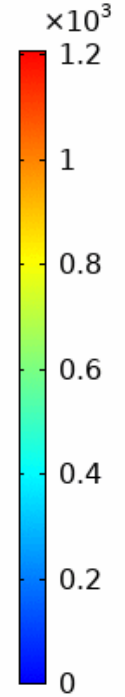
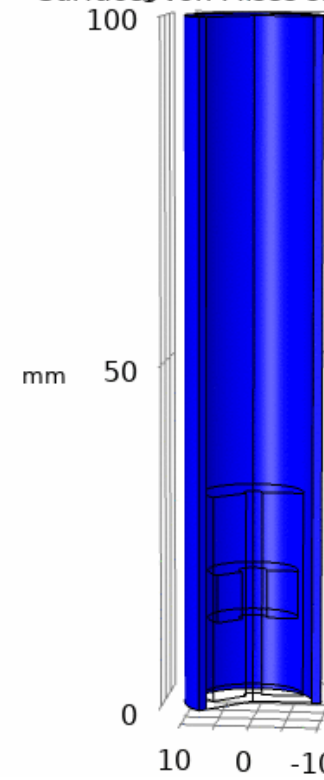




Time=0 s

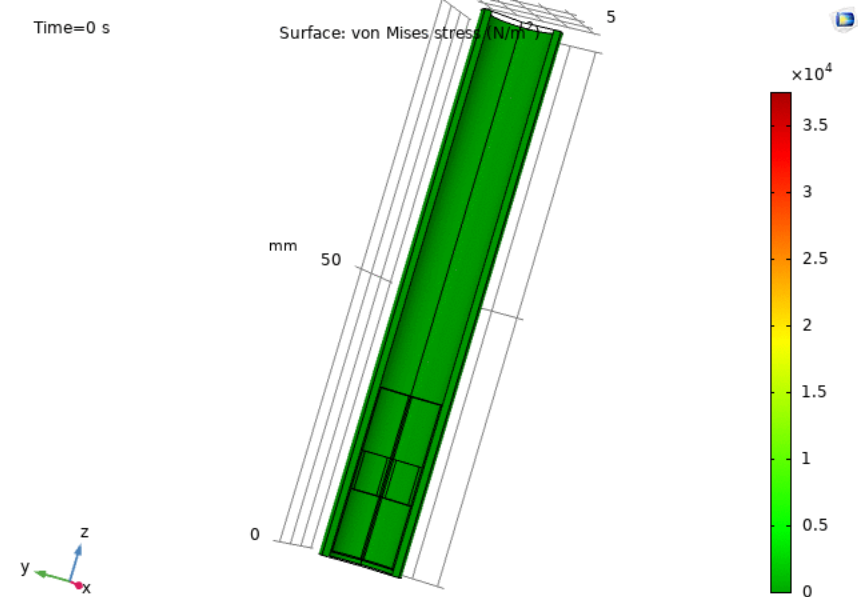
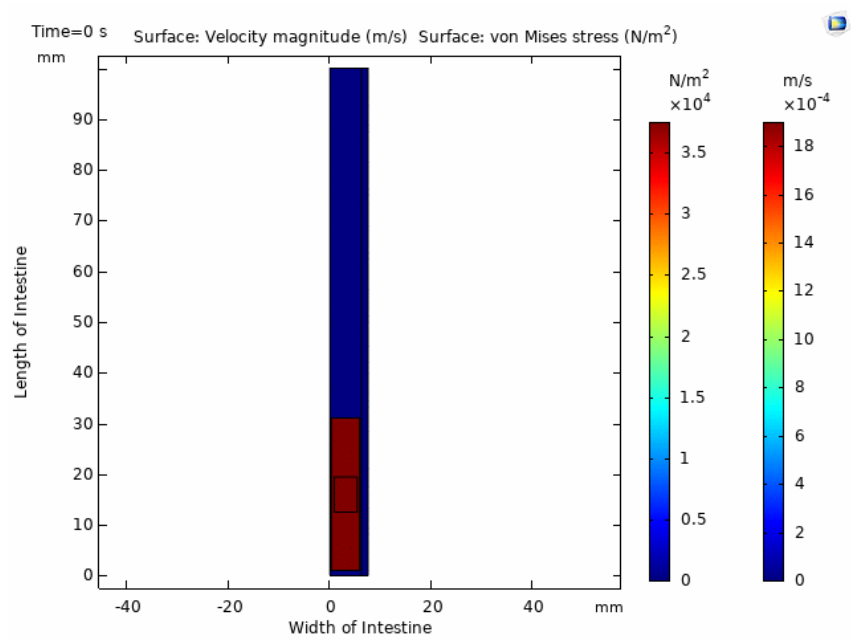


mm
Surface5 von Mises stress (N/m²)
100



SIMULATING PERISTALTIC MOTION



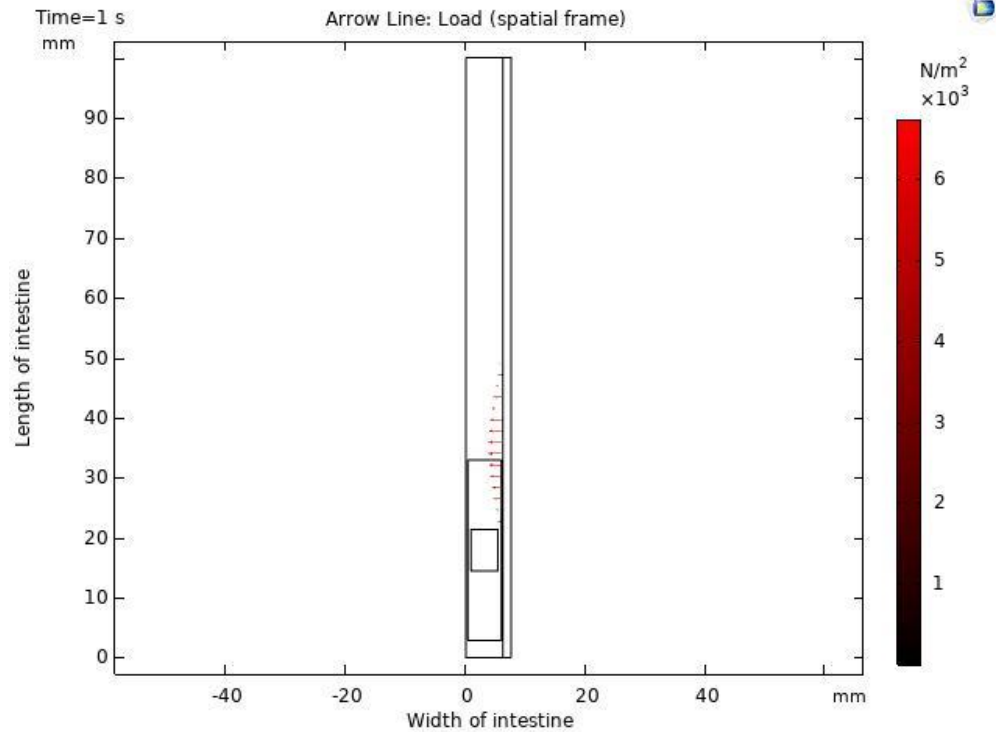


CAPSULE MOVEMENT INSIDE THE INTESTINE

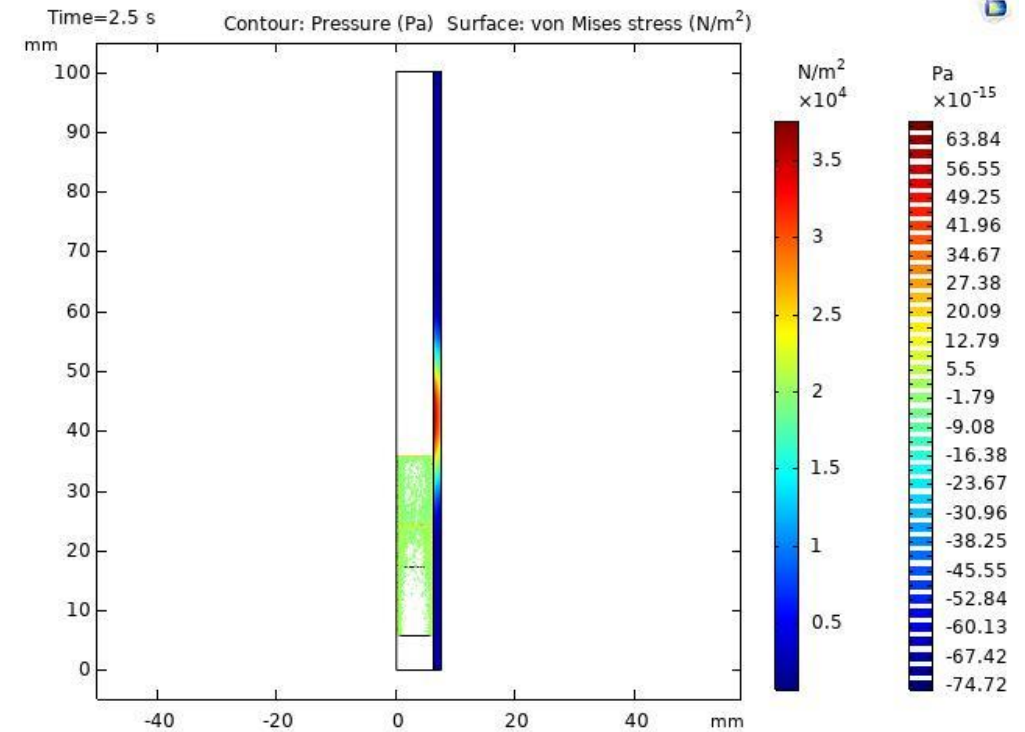


Interaction between Intestine and Capsule

Pressure from intestine (Input)



Stress on capsule (Output)



Future work & Conclusion



Shape memory alloy (SMA) based spring actuator will be incorporated to measure the exact forces from the actuator



The design of SMA actuator will be modified based on findings



The capsule robot will be tested in live tissue (with peristaltic forces) before conducting animal or human trials



References

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6. Rehan, M., Al-Bahadly, I., Thomas, D. G., & Avci, E. Capsule Robot for Gut Microbiota Sampling using Shape Memory Alloy Spring. *The International Journal of Medical Robotics and Computer Assisted Surgery.* 2020. e2140.
7. Phot credits: iStock



Thank You!

