Magnetic Pillcam Background Paper Presentation

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Project Background

PillCam

- A minimally invasive device developed as an alternative to endoscopic devices.
- No active robotic control on PillCam
  - Movement of a PillCam in GI-tract relies on passive body movements
- PillCam comes in a model with a camera on both ends and a model with a camera only on one end

Figure 1: PillCam

https://www.medtronic.com/covidien/en-us/products/capsule-endoscopy/pillcam-sb-3-system.html

Project Background

MagnetoSuture

- Technology that uses electromagnetic fields to control a magnet's motion
- Consists of four electromagnet coils (EMs) arrayed in a plane separated by 90 degrees
- EMs are controlled by wireless remote controller and individual coil current ranges from −20 A to 20 A
- Using this wireless remote controller, a needle or magnet can be moved in any direction in the space between the coils

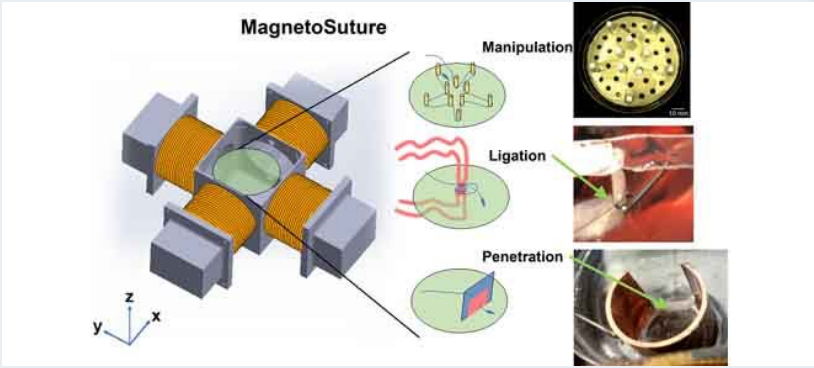
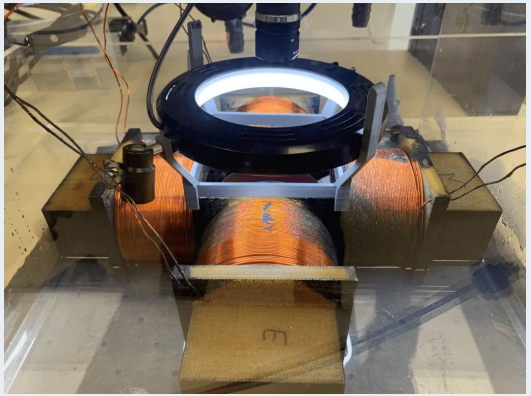


Figure 2-3: MagnetoSuture



https://www.researchgate.net/publication/340723819_MagnetoSuture_Tetherless_Manipulation_of_Suture_Needle

A localization method for wireless capsule endoscopy using side wall cameras and IMU sensor

Seyed Shahim Vedaei* & Khan A. Wahid

Vedaei, S. S., & Wahid, K. A. (2021, May 27). A localization method for wireless capsule endoscopy using side wall cameras and IMU sensor. Nature News. Retrieved April 26, 2022, from https://www.nature.com/articles/s41598-021-90523-w

Summary

Researchers design a build a wireless capsule that can detect movement via a IMU and 4 monochromatic cameras.

We selected this as this paper deals with the same challenges we have been facing with this project, specifically getting the components to be small enough to swallow

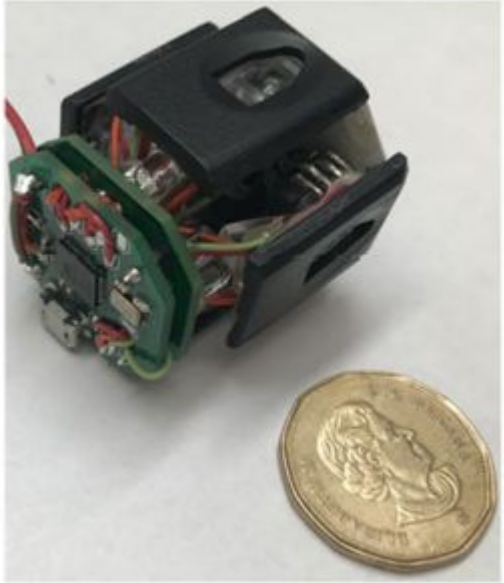


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Figure 4: IMU prototype

Technical Approach

The device has 4 cameras, one on each of the walls of the device, an IMU (MPU9250), an RF transceiver (Lora RF), a battery and a microcontroller (ATmega32U4).

The device only collects and sends the raw data out to a data logger and does not do any of the calculations on board.

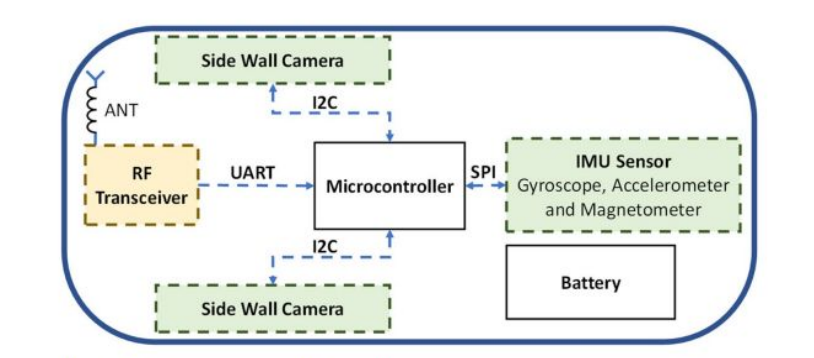

Figure 5: Schematic View of Capsule

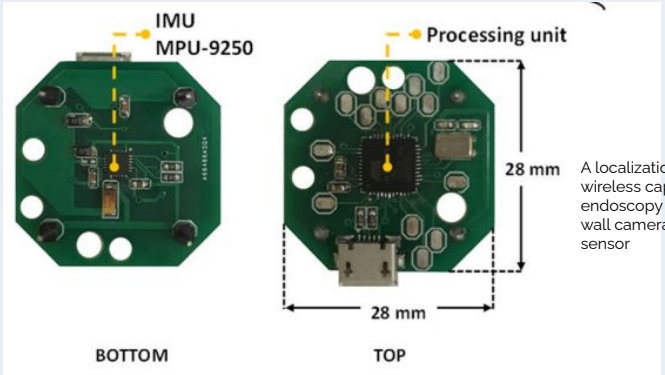

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Figure 6: Component View

Technical Approach IMU

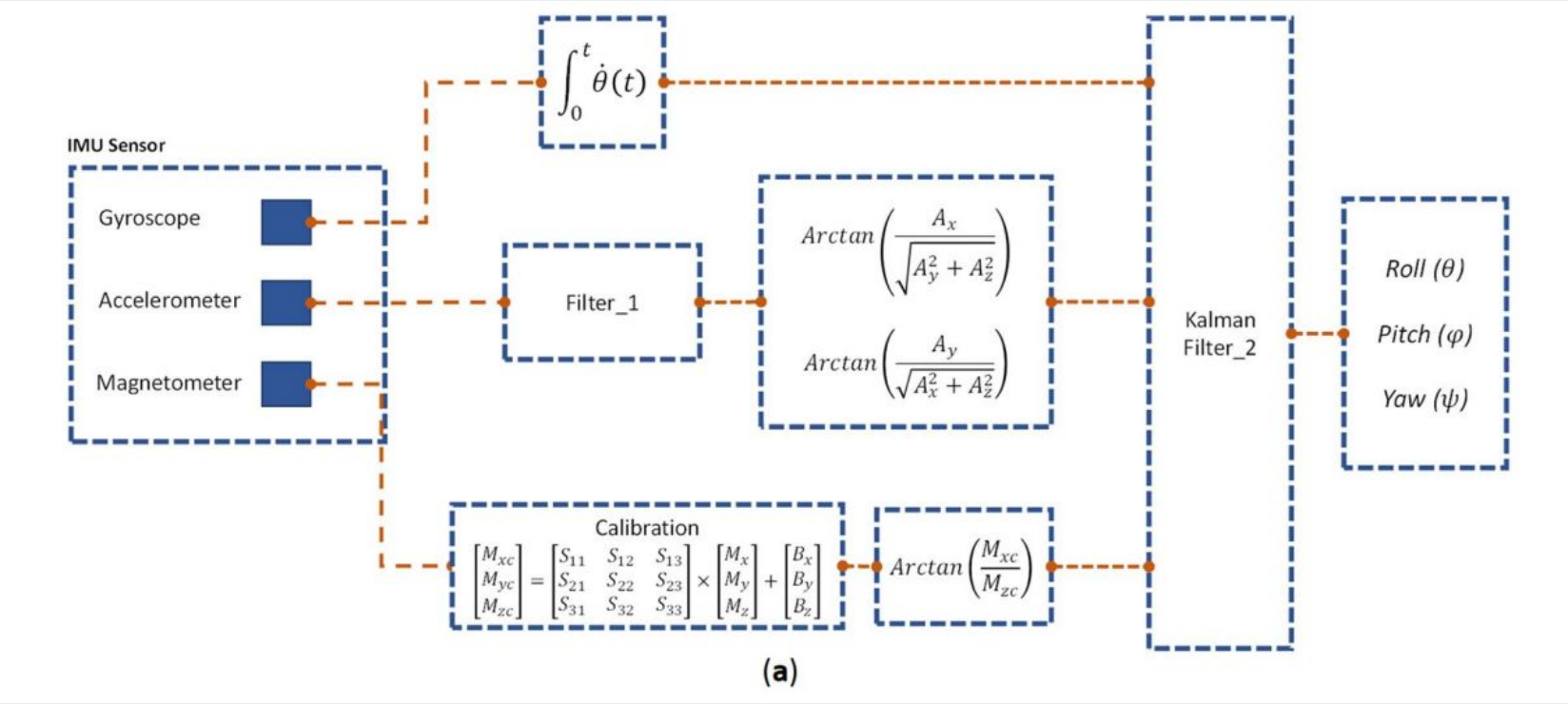

Figure 7: Filtering Approach

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Technical Approach Cameras

The cameras work similarly to optical mice and looks for changes in images every 10ms on an 18x18 pixel image

The camera could pick up motion on any surfaces but walls with parallel patterns

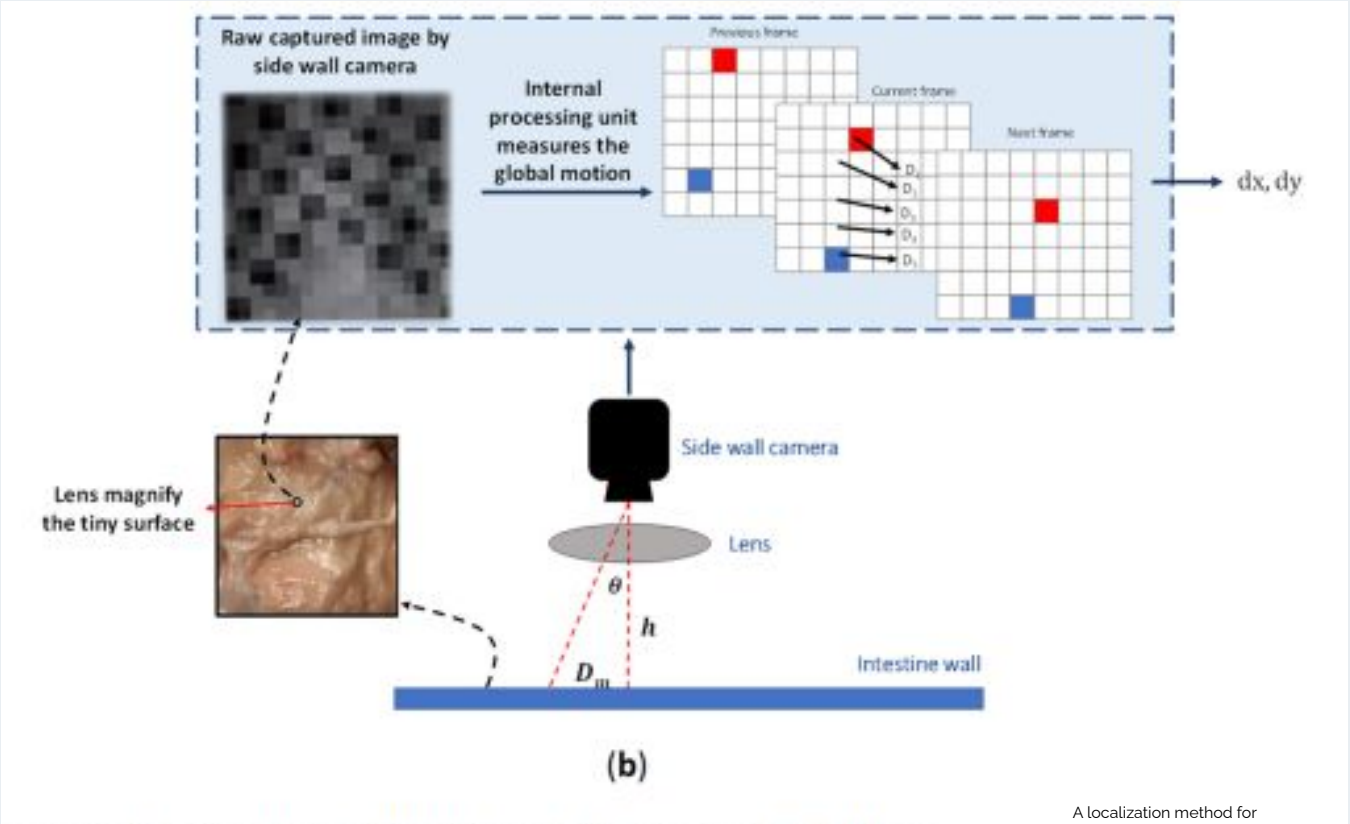

Figure 8: Camera Integration

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Results

The test involved moving the device through a porcine intestine and having it track a known trajectory.

It was able to track the general shape of the trajectories with an average error of 0.95cm which is in the lower end of accuracy to localization methods

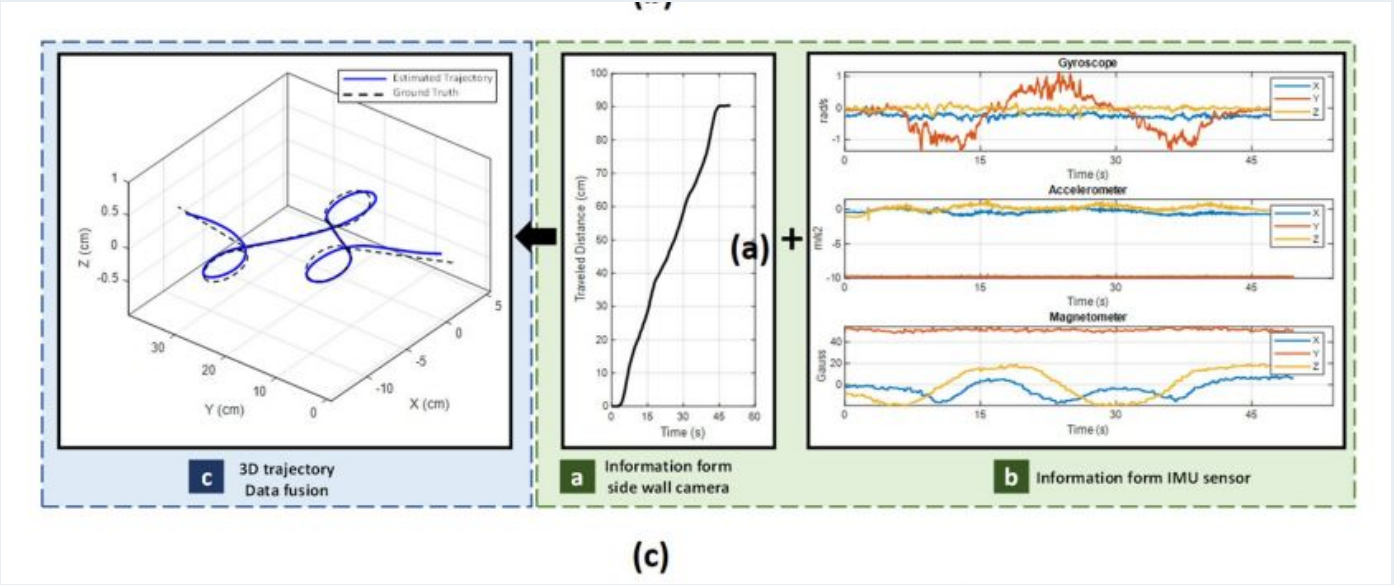

Figure 9: 3D Tracking for several trajectories

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Assessment

- Pros
  - The device had a localization error of less than 1.0 cm
  - The paper had a fusion algorithm for overcoming the drift in the IMU's
- Cons
  - The device is 3.5 x 3.5 x 4.0 cm
  - The device requires to be pushed up against the intestine for the cameras to work so making it smaller may drastically reduce the effectiveness of this system

WiiLab: Bringing Together the Nintendo Wiimote and MATLAB

Jordan Brindza, Jessica Szweda, Qi Liao, Yingxin Jiang, Aaron Striegel

WiiLab: Bringing together the Nintendo Wiimote and Matlab. IEEE Xplore. (n.d.). Retrieved April 26, 2022, from https://ieeexplore.ieee.org/abstract/document/5350509

Summary

- Documenting a MATLAB package designed to teach undergraduate students about MATLAB and system integration
- Integrates the Wii Remote with MATLAB and able to collect location data
- Wii Remote has the bluetooth connection configurations available
- Key Features of the Wii Remote includes buttons, tactile response, and accelerometers

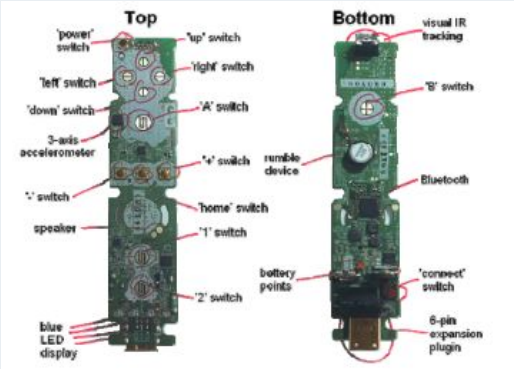

Figure 10: Wii Remote

Assessment

- Pros
  - Integration with Wii Remote is very well done and presented in a simple fashion for students with graphing capabilities as well
- Cons
  - Paper does not tackle any other applications besides the classroom setting
  - Very simple program and much more foundational

Application

- Ability for our PillCam to be integrated into the workflow as well in the future
  - Moving the Wii remote will allow for the PillCam to move as well in the corresponding direction
    - Wii Remote can act as a better model to control PillCam and therefore easier to control
  - Bluetooth provides an ease of access for testing
  - Very intuitive direction controls

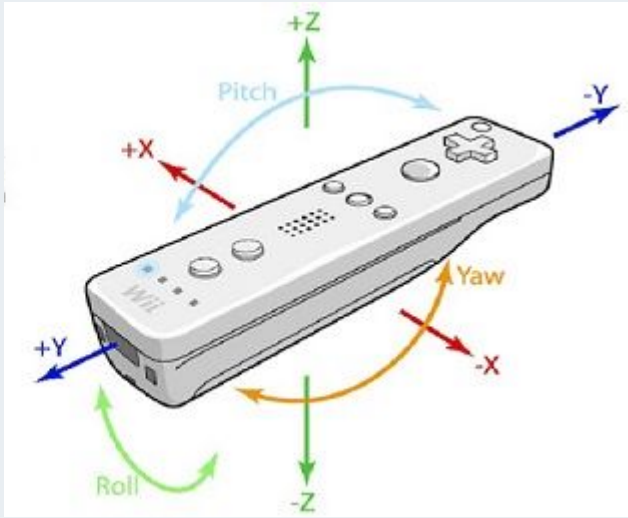

Figure 11: Wii Remote Coordinate System

Citations

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WiiLab: Bringing together the Nintendo Wiimote and Matlab. IEEE Xplore. (n.d.). Retrieved April 26, 2022, from https://ieeexplore.ieee.org/abstract/document/5350509