Project Updates: 12-04-2024

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Introduction

- **Supervision Meetings:**
  Consists of a listing in table format of the supervision meetings that have occurred since the last update, including dates, attendees, and a brief description of discussions and actionable items.
- **Actionable Items Recap:**
  Consists of a listing in table format of the actionable items from the previous week, briefly discussing the progress made and pending tasks.
- **Additional Project Updates:**
  Consists of updates that weren't 'actionable items' from the previous week, such as brief overviews of experiments conducted, data collected, and research findings.
- **Next Week's Agenda:**
  Consists of a listing in table format of the actionable items to complete before the next weekly update, including task descriptions, rough timelines, and success metrics.
- **Comments & Concerns:**
  Consists of a brief analysis of comments or observations about other aspects of the project, such as facilities, work environment, and any outside interest in the project. Furthermore, outlines any concerns about the project.

1 12-04-2024

1.1 Supervision Meetings

1.1.1 09-04-2024

Attendees: Sidharth Shanmugam, Paul Mitchell

Agenda:

- Pi Camera recording script has now been completed:
  - Instead of recording the direct output from the sensor, I am recording from the Pi's Image Signal Processor (ISP) hardware module that converts the 'Bayer' data into a human-readable format such as BGR888 (which also is natively supported by the OpenCV library) without any noticeable performance sacrifices.
  - By using the ISP module, the output resolution can be scaled to minimise disk write speed bottlenecks. As an extra precaution, I have written logic to record directly to a RAM buffer, which is then offloaded for format conversion when recording has stopped. I have also implemented logic to fix the recording framerates and have set it to default at 30 FPS, the sensor supports up to 60 FPS.
  - The output recorded file is a stream of binary data in BGR888 format, for easy playback such as on VLC, I have written logic to convert this file into an .MKV using a lossless encoder (FFV1).
  - Although not mentioned to Paul yet (sorry, forgot to mention this during the supervision meeting), I have been having trouble trying to focus the Pi Camera lens, it's almost like the lens is not compatible with the Global Shutter camera, perhaps the camera has a slightly different construction compared to the Raspberry Pi High Quality Camera. Ben is aware and has experienced the same issue, he has ordered a new lens.
- Backscatter simulation software:
  - Following our last meeting where the delays in underwater testing were discussed, Ben suggested I write a program that simulates the movement of bubbles to test my system. I have now completed writing this software - the program simulates bubbles rising from the bottom to the top of the screen.
  - I have added randomised axis velocities (horizontal and vertical axes) to ensure the bubbles don't follow a linear path as this will help verify the performance and accuracy of my backscatter tracking implementation (which will be developed in the near future). As bubbles rise underwater, they get bigger due to the pressure difference, I have added logic to grow the bubbles as they rise - this will be useful to track performance and accuracy of the system as bubbles change appearances.
  - Instead of exporting the simulation as a video, I have decided to export images of each frame. This behaviour matches how the Pi Camera will be interfaced with in the system - inside of a 'while'-loop, each iteration denotes a frame, the software will retrieve the Pi Camera's frame output array, essentially allowing for direct control of the system's recording frame rate.
  - I have also added logic to export a CSV dataset of every bubble's centre coordinates and radius in every single frame of the simulation. This will provide a synthetic ground truth which I can directly use to quantify my system.
- Initial report feedback:
  - I really appreciated the feedback, there was a lot of important suggestions that I can use for my fimal report to enhance my grade (I'm really hoping to achieve an overall grade of

80%+ :-)).

- I will need to re-evaluate my objectives for the project as I won't have enough time to achieve all of them - I'm making great progress with the first objective of reliable backscatter cancellation system, with that done, I can start to make progress with the real-time research objective. The final objective regarding tracking and pre-emptive cancellation may need to be scrapped.

Actionable Items:

Milestone V1:

- I already have a system that implements the features for V1: (a) simple Canny-based segmentation, (b) real-time metric tracking, I just need to update this to complete the third objective to optimise for test footage of bubbles recorded from testing tank. Since we don't have the tank ready yet, I will optimise this for my bubble backscatter simulation output instead.

1.2 Actionable Items Recap

1.2.1 Script to record from Pi Camera

Progress Report:

- *Done!*

Pending Tasks:

- *None.*

1.2.2 Backscatter simulation program

Progress Report:

- *Done!*

Pending Tasks:

- *None.*

1.2.3 Recording underwater footage from the ISA tank

Progress Report:

- The housing is now sealed up correctly, the Pi is accessible via SSH through Ethernet, and my Pi Camera recording script works perfectly. The live preview feed is extremely useful especially when trying to apply fine adjustments to the camera (focus/aperture).

Pending Tasks:

- There are still some health and safety/other administrative issues that must be resolved before using the ISA tank. Once this has been completely checked-off, I should have access to record footage.

1.3 Additional Project Updates

1.3.1 Laptop Issues

- In the last update on Friday, I mentioned that the laptop had been given to a repair centre to fix the flexgate issue and it would be back by that Sunday.
- It took them an entire week for them to get to open up the laptop housing, and another few days of diagnosis just for them to get back and say that the entire display unit needs to be replaced :-(.
- I ended up collecting my laptop back without any repairs done to it, I am managing with external monitors and of course my iPad which I'm using to mirror my laptop screen using Sidecar.
- I have spoken to a few repair centres near York, one in York and one in Bradford that are offering a service to repair the cable itself - apparently they cut the cable where it's damaged, and solder in a small section of a similar donor cable. This will add a few millimeters of flex cable length to ensure this issue will not happen again in the future.
- Hopefully the issue will be fixed by Monday. I'm so glad I added in the two weeks of buffer time in the Gantt schedule for this as this issue has caused so many delays.

1.4 Next Week's Agenda

1.4.1 Monday - Reach milestone V1

Actionable Items:

- All that needs completion is logic to implement logic to track real time metrics. This needs to be ported over to the codebase from my prototyping code.

Success Metrics:

- Code pushed to the git repository.

1.4.2 Wednesday - Implement PREEMPT-RT kernel and quantify (Milestone V2)

Actionable Items:

- Implement the PREEMPT-RT kernel along-side the standard kernel.
- Quantify the performance differences with the V1 software.

Success Metrics:

- Analysis logged in the project journal

1.4.3 Friday - Snake-based segmentation & tracking (Milestone V2)

Actionable Items:

- The V1 system uses Canny to detect edges, with the detected edges passed to OpenCV's findContours() method to extract closed loop edges. The cancellation logic then uses a minimum enclosing circle (MEC) implementation which calculates a circumcircle which completely covers the minimum area of the detected contour. The MEC implementation must be replaced with the snake method.
- The 'least distance rule' and Kalman filter approach must be researched for the backscatter tracking implementation in the system.
- I will be putting the parallax part of 'Project holes and mitigate parallax' task on pause until the final housing is completed and the ISA tank is functional.

Success Metrics:

- Code pushed to the git repository.

1.5 Comments & Concerns

No comments or concerns at the moment.