Project Updates: 26-04-2024

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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 26-04-2024

1.1 Supervision Meetings

Like last week, we didn't have any normally scheduled supervisions this week as Paul was out of the office. However, I did meet with Ben to talk on many occasions across the week.

Agenda:

- PREEMPT-RT kernel worsens system performance.
  - Just like the research and experimentation with multiprocessing, implementing a real-time kernel with PREEMPT-RT proved a failure, even though, in theory, it should've improved at least the system stability by maintaining a constant frame processing time.
  - The results showed a 1ms rise in the average frame processing time, which is roughly a 16% increase. Not only this, but the stability is also worse, as the standard deviation in processing time for each frame increased by almost 60%.
- Tank recording.
  - Recording was successful and the results were also great as the system worked quite well to detect just the backscatter in the foreground without any confusion about the background texturing - this is quite important as the system must work only for backscatter and not any region of interest that needs recording.
- Final report.
  - I have started planning this report, I wanted to give Paul a quick overview of how I have planned to structure this report, however, he was quite busy so this conversation did not proceed.
  - I have reached out to Simon Bale to clarify if we can reuse parts of the initial report in the final report - since, in my opinion, it makes more sense to use the initial report as a foundation, which the final report builds on. I am awaiting Simon's final response on this matter before I start writing content.

Actionable Items:

- Quantify real-time performance of the system with underwater recording.
  - At the moment, I've only quantified the real-time performances using my synthetic bubble simulation, however, with the underwater footage now recorded, it would make sense to quantify that to gauge the true system performance.

1.2 Actionable Items Recap

1.2.1 Recording underwater footage

Progress Report:

- *Done!*

Pending Tasks:

- *None.*

1.2.2 Implement PREEMPT-RT kernel and quantify

Progress Report:

- *Done!*

Pending Tasks:

- *None.*

1.2.3 Snake-based segmentation & tracking

Progress Report:

- *No progress due to PREEMPT-RT backlog.*

Pending Tasks:

- 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 that 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.

1.3 Additional Project Updates

1.3.1 Skipping the predictive system objective.

- Unfortunately, due to very tight project time constraints, I will not have enough time to work on this research objective. It's a shame that I have to skip this, as I was very interested in researching how AI can accelerate unconventional use cases such as this.
- I will be focusing more on quantifying the real-time aspects and researching optimisations for more accurate backscatter segmentation and cancellation.

1.4 Next Week's Agenda

1.4.1 Wednesday - Parallax and offset calibration.

Actionable Items:

- While recording the test footage in the ISA tank, I noticed a large offset between where the camera was recording and where the projector was projecting. There is some overlap between the two, where the system can effectively work, so I will need to plan and implement some logic in code that can automatically find the overlap region and crop the feed/projection.
- I also noticed some image distortion which also needs resolving. This can be done quite simply by projecting a chessboard, capturing it at various angles, and passing it into an OpenCV function that can calculate a distortion matrix which can be used to undistort the captured image frame.
- The auto-cropping feature is very complicated to implement, so this task may be entirely postponed or skipped as it is unlikely we will be doing any more experiments in water due to the project's time constraints.

Success Metrics:

- Code pushed to the Git repository.
- Image cropping visually verified.
- Image undistortion visually verified.

1.4.2 Wednesday - 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 that 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 likely need to implement and test the tracking implementation using my synthetic bubble simulation as the tank footage of bubbles isn't very trackable.

Success Metrics:

- Code pushed to the git repository.

1.4.3 Friday - Complete the 'Introduction' section of my report.

Actionable Items:

- Hopefully by Monday, I will receive confirmation from Simon regarding the final report. Once I have received this, I will be able to start writing the report. I will aim to complete the 'Introduction' section and maybe even make a start on the next section which covers the background information.

Success Metrics:

- LaTeX code pushed to the git repository with a compiled PDF.

1.5 Comments & Concerns

No comments or concerns at the moment.