Open Access Labs: A Method to Opening Student Minds

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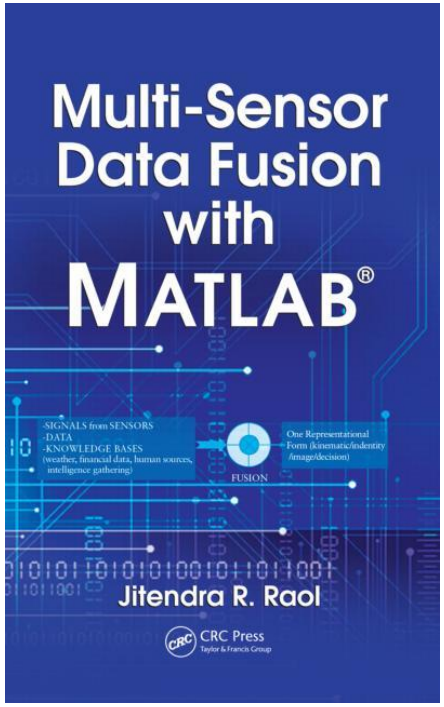
Agenda

- Background and Framework
- Motivation
- Risks and What we did
- Successes
- Recommendations

Background and Framework



Course Textbook

Multi-Sensor Data Fusion with MATLAB textbook used for course

- New course was launched in Winter 2016.
- Course launched as a special topics and did not have a dedicated lab slot in the calendar
- Course instructor saw the needed for a lab in the course to solidify the concepts
- First lab was designed as a traditional lab. Students would book lab slot and complete the lab
  - Students were very stressed and did not enjoy the labs

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Background and Framework

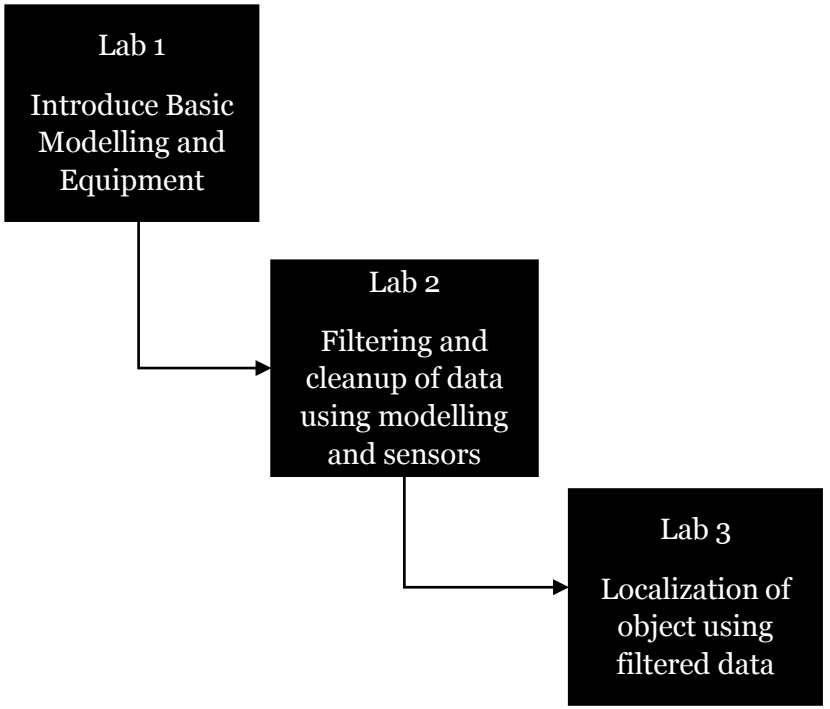
- Fourth year students have very chaotic schedules. To accommodate the second lab was modified to be open hours
- Followed outline used in ECE 481/484 and setup stations to be self contained for students to do on their own, at their own schedule
- Modified labs in 2017 to be completely open from the beginning.

ECE 481/484 Lab

Existing lab setup for ECE 481/484

Motivation

- What we did in the lab
  - The labs were designed to be self contained but each lab built on knowledge obtained in the last lab. The students were given 24/7 access to the equipment and the benches were coordinated with an online booking system.
- Who did we talk to?
  - Had buy in from the course instructor, lab instructor and program director



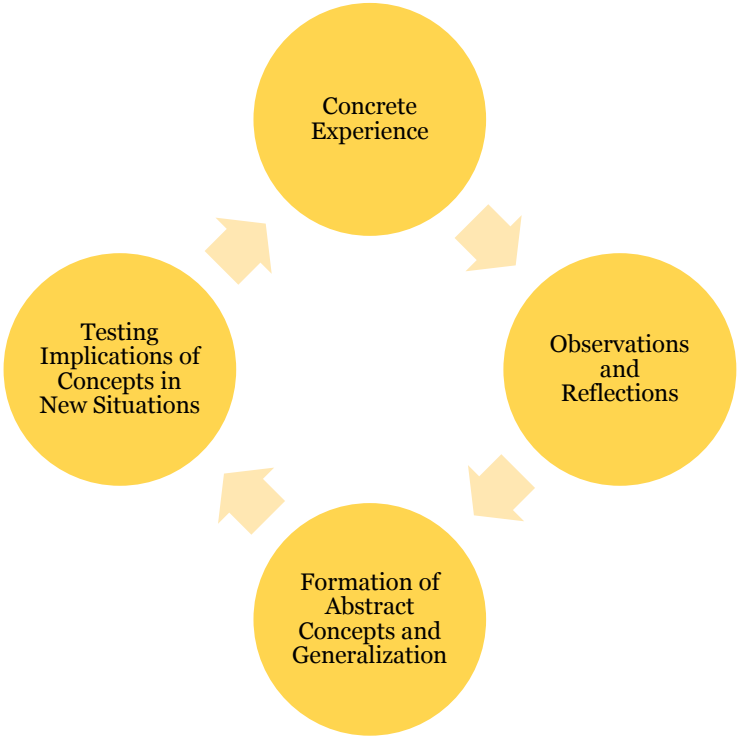
Pedagogical flow of labs used in the course

Risks and What we did

- Who's to blame if things go wrong? What should we be aware of?

Monetary Risks	Health and Safety	Student Engagement	Lab Completion	Falling down the rabbit hole
Cheap parts!	Low power with auto shut off	Emphasized applicability in other projects and aspects of career	Sufficiently long time in the schedule for students to complete	Later course content often addressed many questions

What we did



Reflective Practise Cycle

Cycle of Reflective Practise Implemented in the Course

- Emphasized exploration, analysis and discussion.
  - We're more interested in seeing the student's engineering judgement and analysis.
  - Proper analysis of failed results is still worthwhile, they can identify why things failed and recommend corrective action for next time
- Would we try this with a lower level course? Maybe. Jury is still out

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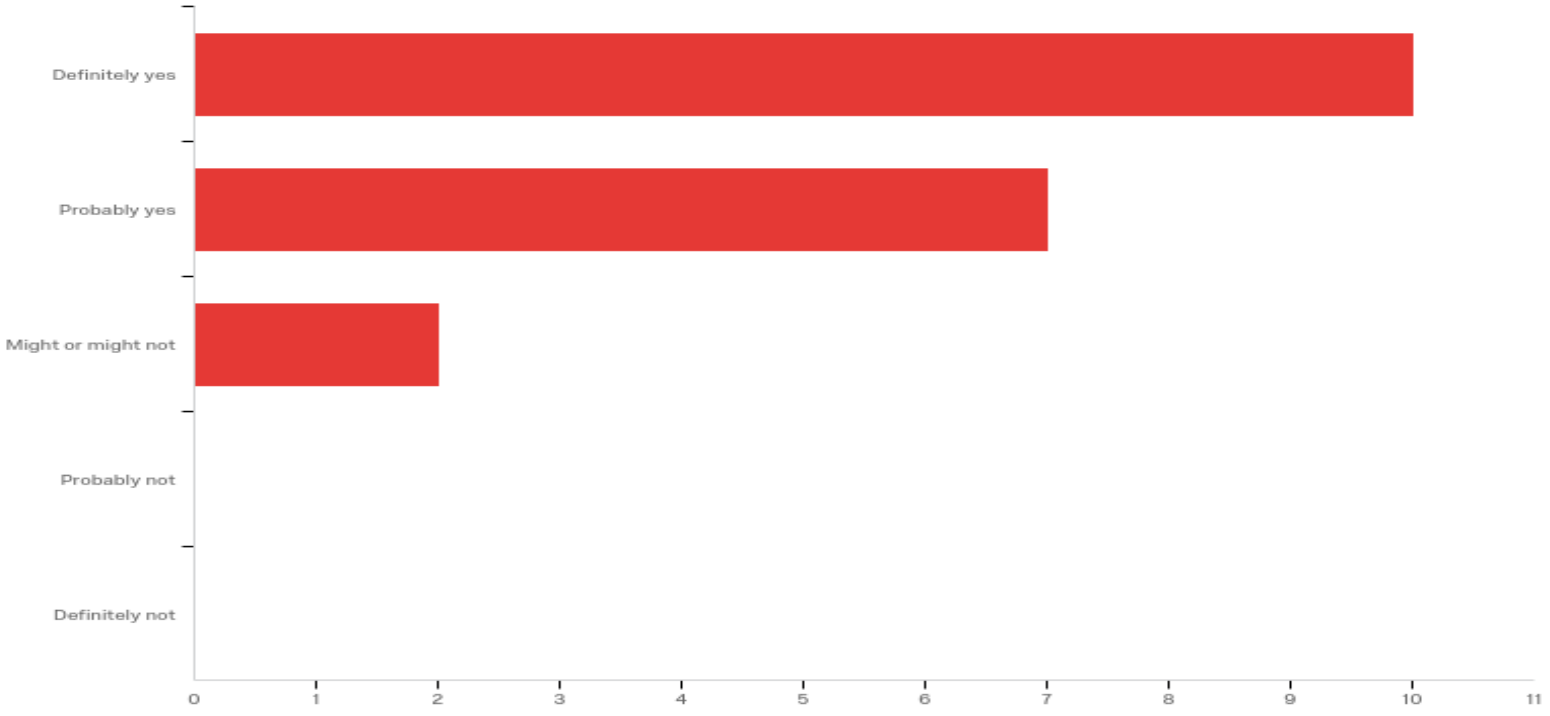
Successes

- The students are running into problems, but is it worth it?
- Data says yes. They're exploring, asking questions and actually understanding the algorithms

Successes

- Q2 - Did you find the labs helped you learn the concepts of the course well?



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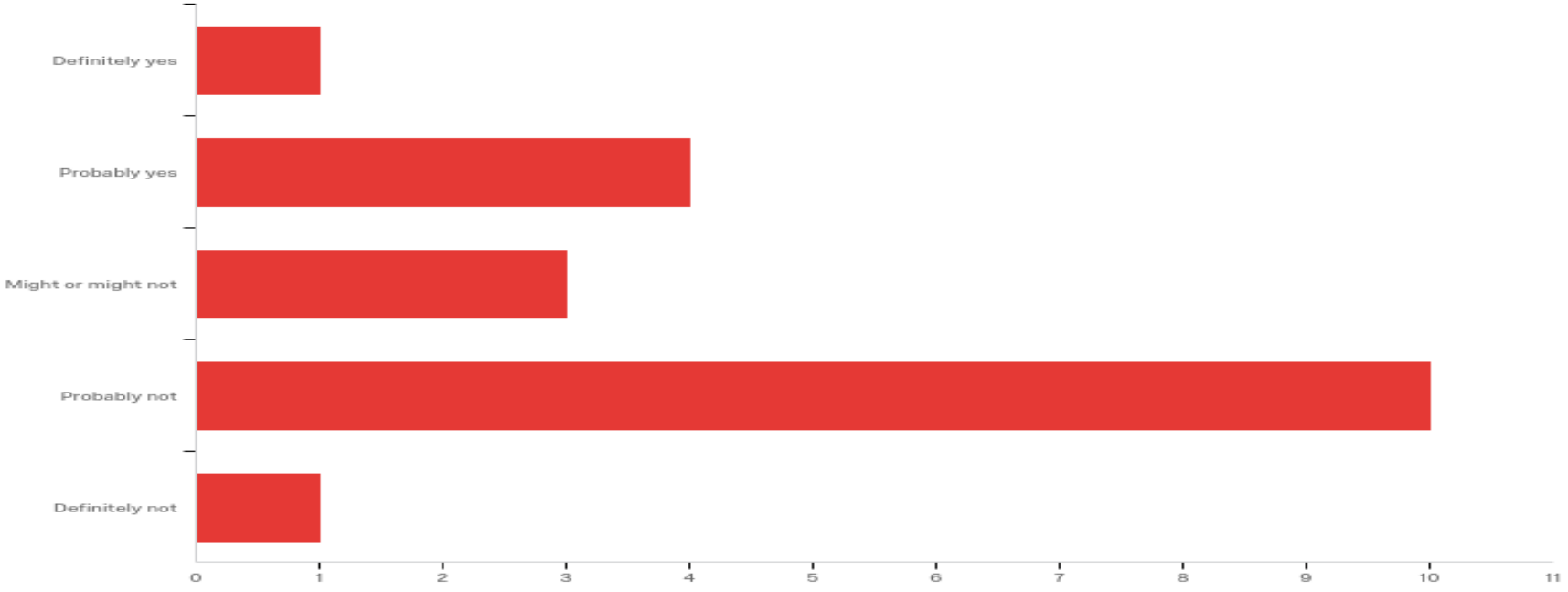
Successes

- Q4 - Do you think you could have investigated the material as well if you complete the lab in a set lab session? (e.g. Set 3 hour lab slot)



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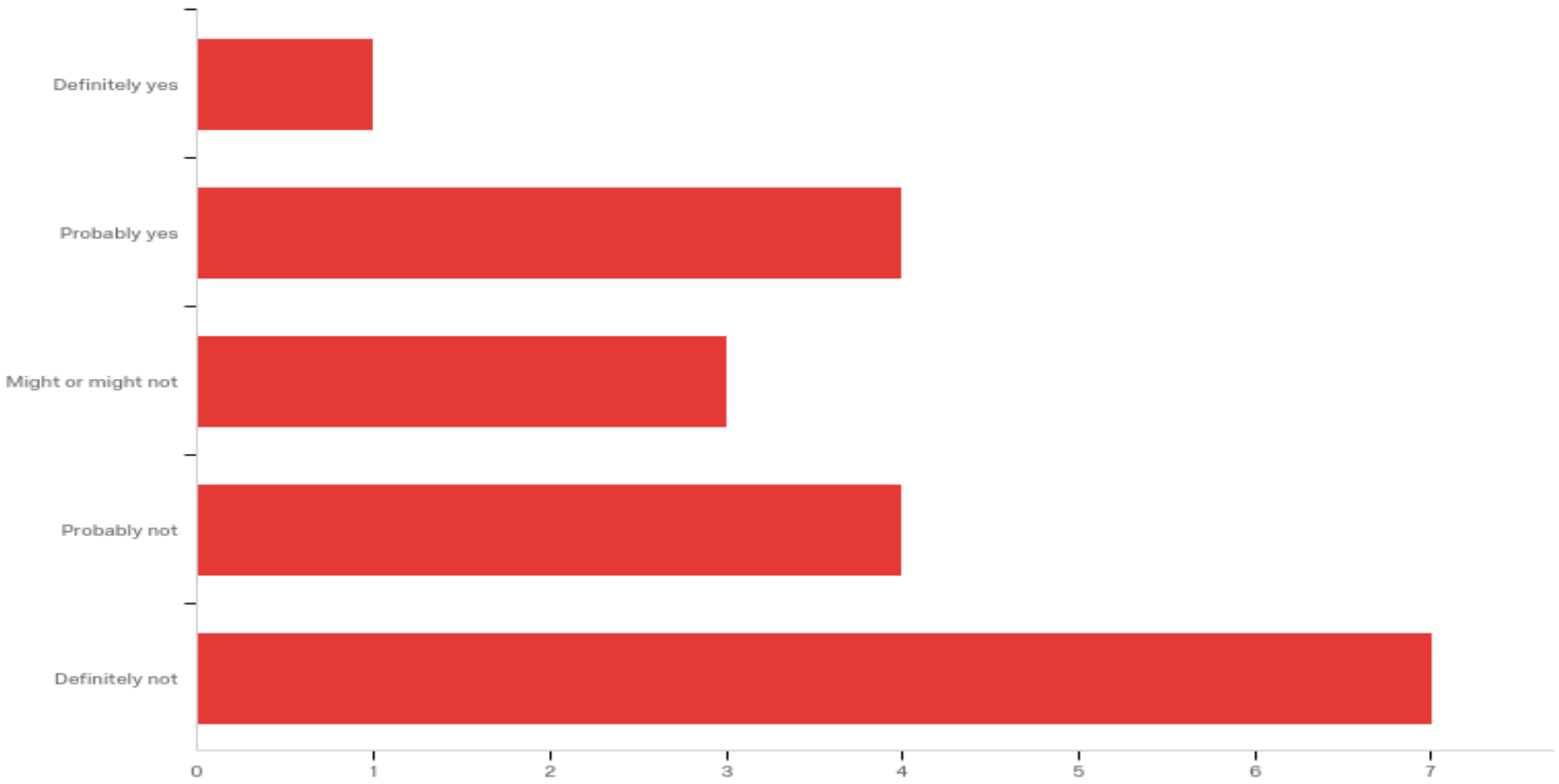
Successes

- Q5 - Would you have preferred scheduled lab times?



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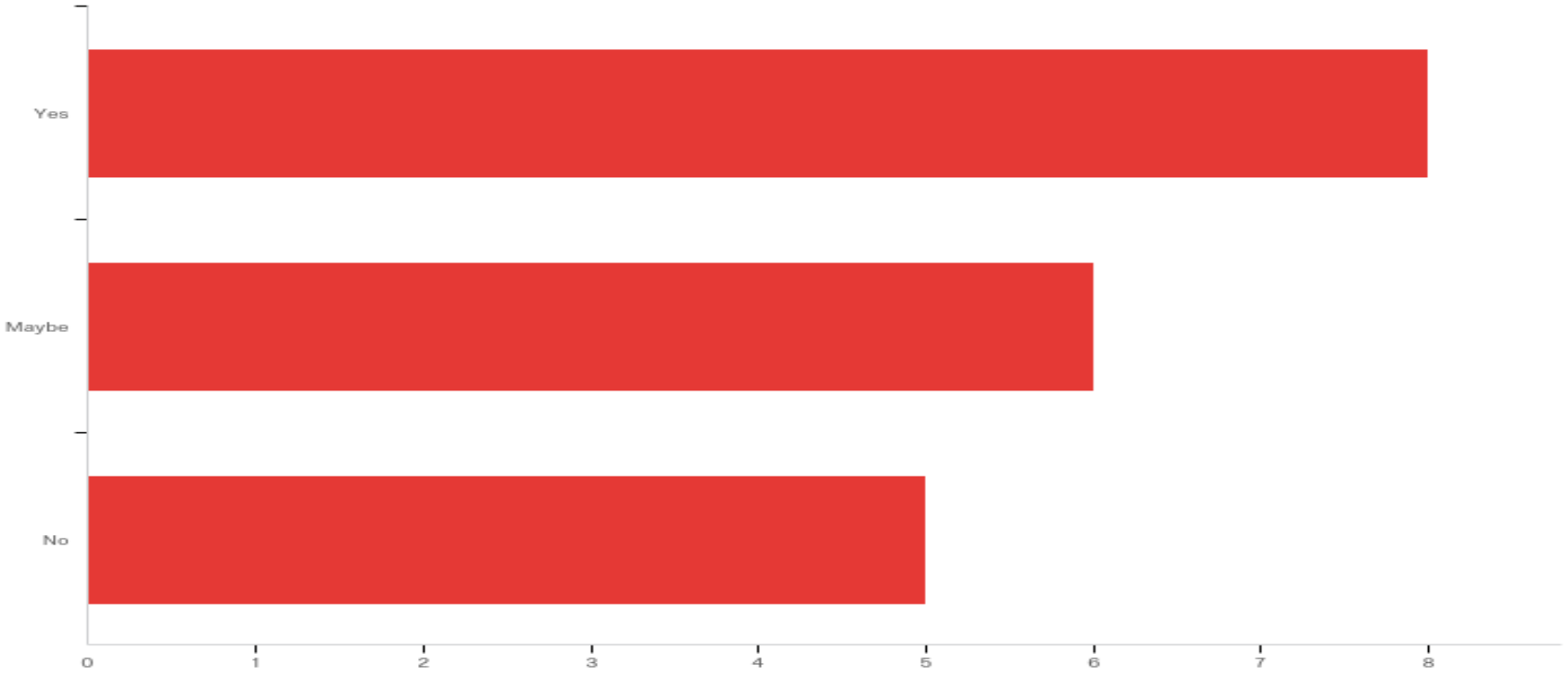
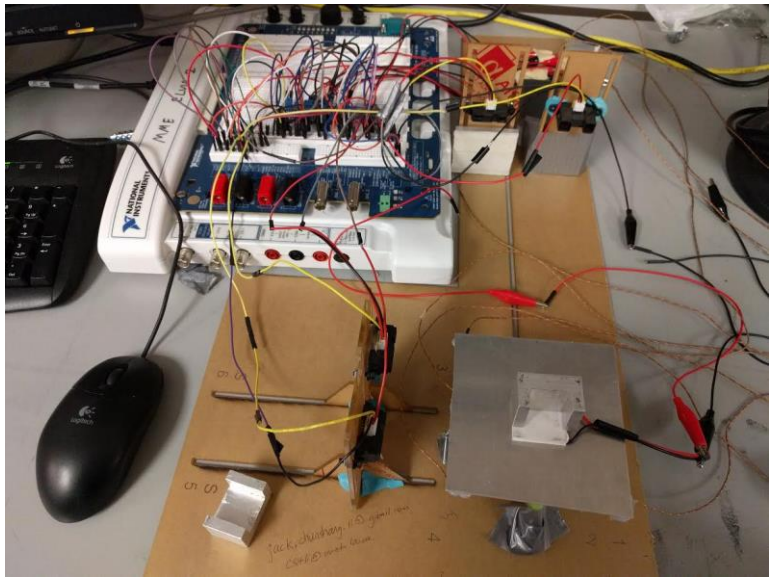
Successes

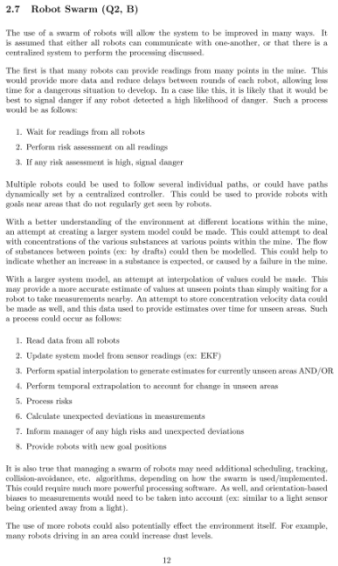
- Q9 - Did you get a chance to explore concepts not directly outlined in the lab manual?



Recommendations



EXAMPLE.1: Current Lab Setup



2.7 Robot Swarm (Q2, B)

The use of a swarm of robots will allow the system to be improved in many ways. It is assumed that either all robots can communicate with one-another, or that there is a centralized system to perform the processing discussed.

The first is that many robots can provide readings from many points in the mine. This would provide more data and reduce delays between rounds of each robot, allowing less time for a dangerous situation to develop. In a case like this, it is likely that it would be best to signal danger if any robot detected a high likelihood of danger. Such a process would be as follows:

1. Wait for readings from all robots
2. Perform risk assessment on all readings
3. If any risk assessment is high, signal danger

Multiple robots could be used to follow several individual paths, or could have paths dynamically set by a centralized controller. This could be used to provide robots with goals near areas that do not regularly get seen by robots.

With a better understanding of the environment at different locations within the mine, an attempt at creating a larger system model could be made. This could attempt to deal with concentrations of the various substances at various points within the mine. The flow of substances between points (ex: by drafts) could then be modelled. This could help to indicate whether an increase in a substance is expected, or caused by a failure in the mine.

With a larger system model, an attempt at interpolation of values could be made. This may provide a more accurate estimate of values at unseen points than simply waiting for a robot to take measurements nearby. An attempt to store concentration velocity data could be made as well, and this data used to provide estimates over time for unseen areas. Such a process could occur as follows:

1. Read data from all robots
2. Update system model from sensor readings (ex: EKF)
3. Perform spatial interpolation to generate estimates for currently unseen areas AND/OR
4. Perform temporal extrapolation to account for change in unseen areas
5. Process risks
6. Calculate unexpected deviations in measurements
7. Inform manager of any high risks and unexpected deviations
8. Provide robots with new goal positions

It is also true that managing a swarm of robots may need additional scheduling, tracking, collision-avoidance, etc. algorithms, depending on how the swarm is used/implemented. This could require much more powerful processing software. As well, and orientation-based biases to measurements would need to be taken into account (ex: similar to a light sensor being oriented away from a light).

The use of more robots could also potentially effect the environment itself. For example, many robots driving in an area could increase dust levels.

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EXAMPLE.2 Typical Exam Response

Robustness: Cheap components mean things fail easily, can be frustrating and makes the lab look disorganized.

Marking: Marking involves reading fairly lengthy reports. Students often go for quantity instead of quality. Class is an elective so we cap at 50 students and is manageable, but can be streamlined


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