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Mathworks (Sensor Fusion for Autonomous Systems)

Problem Statement:

An autonomous vehicle needs to know its position at any given time in relation to the environment, including but not limited to obstacles, path markings, pedestrians and other vehicles. This is especially true when an autonomous vehicle is in motion. In using a combination of sensors, such as LiDAR cameras and others, we will fuse the data generated by these sensors to create a better situational awareness on a few levels.

In the first phase, will be to determine the distance between the vehicle and other objects in general while in a motionless state. Since the object will not be in motion we will be gathering data at a slower frequency in order to do a baseline. We will be working with multiple lidar sensors and a camera sensor separately and then integrating both using sensor fusion. An important step in this phase would be to incorporate lidar and camera data into our system.

In the second, we will be tracking objects while the Vehicle is in motion. Given the moving nature of this phase we will focus on lane changing as the scenario to focus our efforts. Which would be a matter of improving the location of our sensors and increasing data sampling frequency. A shift in importance of sensor placement means a weighted priority of sensors is essential. This will also have implications for the type of data needs will shift: the transition from snapshots to more of a stream lidar and computer vision data stream.

In the third phase, it will ultimately use sensor fusion to determine the autonomous vehicle’s location in real time in relation to its environment. The fusion of the data on these sensors will increase the pose estimation of autonomous vehicles and thus situational awareness in general. In the fourth and final phase, we will be working on training and testing the dataset and evaluating any inefficiencies in the code.This will be an important phase to test the accuracy of our algorithm. Autonomous systems are important in guiding the future actions of the vehicle and increasing safety measures.

meeting with mathworks liaison so we can ask general questions
this is what we can accomplish with what tools?
can we use python integration?

Tsume
Mathlab meeting will take place ET c159
1:00pm to 1:30pm
from 1pm - 2pm

talk about our general idea that we have
status update for the liaison

if you wanted to create dummy data in matlabs

mathworks is hiring
ask about career opportunities in mathworks the Liason

Machine learning in python to simulate lane changing. Can we integrate it into mathlab?

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Update jira thursday for review on monday

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Next week we will write code in pseudo code exercise

Python will be our language of choice.

Approach:
Phase I: Research and Discovery
1) Focus on research on recent approaches to our problem statement
2) What Tools are available to process that data
3) Discover a usable dataset that we can use to test our algorithm
4) Investigate existing sensor fusion techniques
5) Selecting essential and optional sensors
6) Create GitHub for version control/ tracking
Phase II: Selection of software and toolsets (Matlab, python, tensorflow) Including training
1) Based on research performed, select common Integrated development platform (IDE)
2) Selection of which libraries to be utilized and imported

3) Gain familiarity with MatLab
4) Choose the appropriate matLab toolboxes to help process the sensor data
a) Matlab ML: https://matlabacademy.mathworks.com/#ai
b) Matlab Computer Vision: Image Processing Tutorial
c) Matlab Python Integration: Calling Matlab from Python
Phase III: Design and Implementing
1) Based on our research findings, select an approach to sensor fusion
2) Coding with the existing data sets selected from research phase
3) Taking incremental approach with the sensors:
a) Work with LiDAR sensor integration
b) Work with Camera sensor integration
c) Work with any additional sensor integration
4) Develop neural network implementation of sensor fusion
5) Eat, sleep, code, and repeat
Phase IV: Training and Testing algorithm
1) Testing with selected data sets
2) Testing with alternative data set
3) Work on deliverables: Software design document, code presentation, and other documentation etc.
4) Evaluation, and revision of coding
WorkFlow:
- Split into two teams:
  - Computer vision team
    - Team Member: Angel
    - Team Member: Jonathan
    - Team Member: Hagop
    - Team Member: Gerardo
    - Team Member: Deepanker
  - Object detection team
    - Team Member: Daniel
    - Team Member: David
    - Team Member: Wang
    - Team Member: Roberto
    - Team Member: Patrick

Have people volunteer for the teams and create sub tasks based on team goals.
Execution plan:
October – First 3 weeks Phase I & II
Last week of October
thru
3rd week of November
Phase III
Last week of November
thru
end of Fall Semester.

Phase IV

Notes for Liaison:

talk about our general idea that we have:

We have started breaking down the project into two separate sub groups with a focus on a scenario of ‘lane changing’ to reframe the problem. Two groups are ‘computer vision’ and ‘object detection. Breaking down the problem in terms of our scenario, we have three phases:

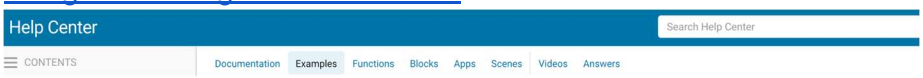
Phase 1) detecting objects in a motionless state using all sensors, by integrating them one by one and testing with all of them. With a lower frequency of sensor data since objects will be motionless.

Phase 2) determining what sensors we need for a moving state. In terms of which objects to track. Adding a weight to the sensor inputs in terms of sensor data frequency. Switching to sensors that can provide the needed data and increasing the frequency of those sensors.

Phase 3) Adding more metrics to test our algorithm: including time and others. And testing the algorithm in different scenarios.

What is the state of the project currently?
We are in the research phase and are looking to narrow down our approach method by determining which tools would be most beneficial to our approach. We have questions about MatLab, python, and tensor flow (machine learning) integration.

Questions

- What amount of computing power is required? Is Arduino a viable option? Raspberry Pi? iPhone? Laptop? Off-Site supercomputer?
    - Minimum specs for a microcomputer?
    - First get
    - Prioritize optimization and cost.
- Specific sensors/brand recommendations?
    - https://www.mathworks.com/hardware-support/home.html
    - Check supported hardware then cross check with project requirements
    - Iron out specific technical requirements for each individual sensor
- Can Matlab generate dummy data (video? or other simulated sensor data?)
    - What will it look like?
    - What's the process?
        i. Driving Secnario
        ii. Driving Simulation to create synthetic sensor data
        iii. Using Unreal Engine for Simulation
        iv. 

    - Recommended existing data sets?:
        i. The KTTI Dataset Geiger, Andreas, et al. "Vision meets robotics: The kitti dataset." The International Journal of Robotics Research 32.11 (2013): 1231-1237.
        ii. ANSFL Dataset A. Shurin et al., "The Autonomous Platforms Inertial Dataset," in IEEE Access, vol. 10, pp. 10191-10201, 2022, doi: 10.1109/ACCESS.2022.3144076.
- What tools are available in matlab to help solve our problem?
    - Recommended Add-ons?
    - Computer Vision Toolbox™
    - Automated Driving Toolbox
    - LIDAR toolbox
    - Navigation Toolbox™/ insEKF
    - UAV Toolbox
    - Sensor Fusion and Tracking Toolbox™
- What can we use matlab for? Testing or to simulate data?
- What tools can we use to integrate lidar and camera Data?
- What solution format is needed? Do we need a matLab centric solution?

- Best use case scenario for MatLab and its toolboxes for our problem?
- How to integrate ML with python with simulation in Matlab
- Any tips on how to succeed in this caliber of a project ?
    - Recommended approach ?
    - How are other teams looking at this problem ?
    - How did previous teams succeed with this project ?

Misc questions not related to project:

- What are the career opportunities with Matlab?

Liaison contact:
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