BIKEWARDS VIEW SIGNALS PROCESSING – V1 HAND ESTIMATION & PLANNING

VARIABLES

$r_{i,k}$ – radius/distance in look direction i @ cycle k

τ – time between measurements at ~~successive p~~ same point

ψ – angular distance between neighboring points.

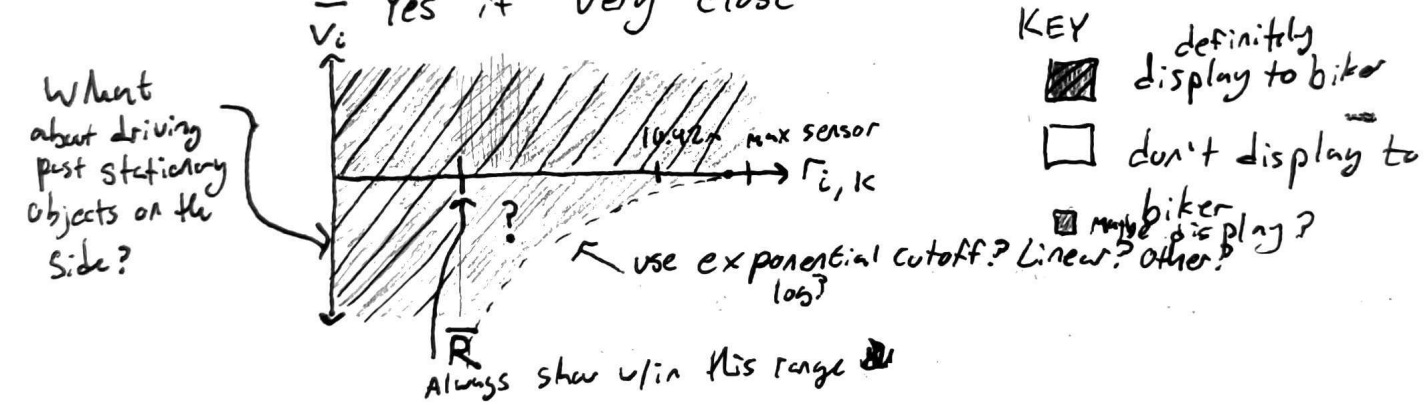
v_i – differential speed in look direction i relative to biker

p_i – object present in look direction i, 0 or 1

1-point model, no effect from neighbors. [Assume bike @ constant speed for now]

$$v_i = \frac{r_{i,k+1} - r_{i,k}}{\tau}$$, v_i non-negative, object moving towards biker

- Show any objects moving toward biker in range
- Show objects moving away from biker?
  - Not at end of range
  - Yes if very close



$$\text{display} = \begin{cases} \text{yes}, & r_{i,k} \leq \bar{R} \\ \text{yes}, & r_{i,k} > \bar{R} \;\&\; v_i > \text{cutoff line} \\ \text{no}, & \text{else} \end{cases}$$

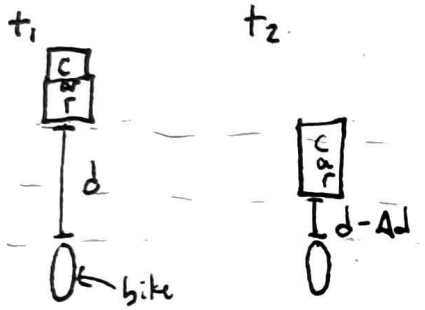
- Should cutoff line vary based off look direction b/c of direction dependence (Moving parallel directly towards sensor/perpendicular to?)

Now acknoledge that the bike could be accelerating or slowing down.

- Should the cutoff line be based on this acceleration?
- Should the cutoff line vary based on look direction b/c acceleration could be in direction of look line or perpendicular to? ↑

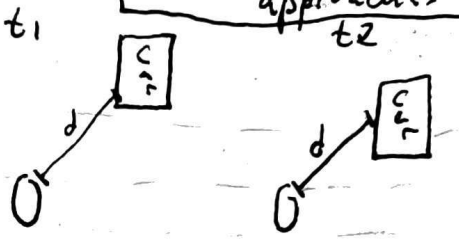
Make me think of velocity note on last page back to that for a second

Scenario 1:



Scenario 2:

⚠ d doesn't change for sensor as car approaches



Solutions to Scenario 2

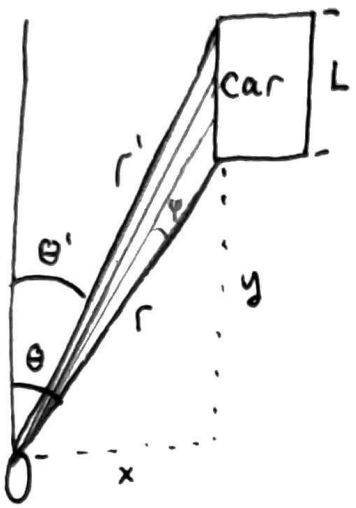
- It's possible a different look direction would be taking the front of the car and not have this problem.
- Neighboring ~~points~~ look direction could tell us whether car is moving forward as they would eventually sense/lose car.
- Always count objects stationary distance?
  - No - traveling along a wall

1- point only works for rear objects so...
increased dependence on neighbors w/ increased angular distance from center

Solution to side sensing problem

Car length 4.5 - 5.5 m

Find possible consecutive ~~points~~ look angles that would have unchanging distance for closest at $\hat{r}$, angle θ, w/ angular res Ψ and car length L



$r = \sqrt{x^2 + y^2}$,

$x = r \cos(90° - \theta)$

$y = r \sin(90° - \theta)$

$r' = \sqrt{x^2 + (y + L)^2}$

$$\theta' = -\tan\left(\frac{r \sin(90° - \theta) + L}{r \sin(90° - \theta}\right) + 90°$$

Max stationary points for car w/ differential speed of 0 kph

$$N = \frac{\theta - \theta'}{\Psi} = \frac{\theta - 90° - \tan\left(\frac{r \sin(90° - \theta) + L}{r \cos(90° - \theta)}\right)}{\Psi}$$

Need to factor in $\lceil$Max stationary points$/2\rceil$ to the side of each measurement.

Begin Algorithm after bicycle acceleration

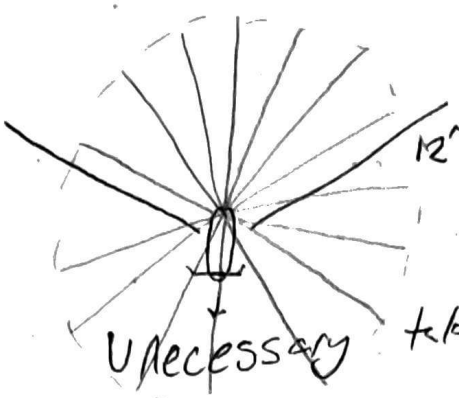
- Also need to filter out objects driving past objects that will come in from front rather than rear
- If object not falling back fast enough could have gotten partly past it before it sped up again.
- Could two sensors on one side achieve this?
  - Theoretically it would come into the back first
  - Ignore objects when front sensor gets shorter range first?
    - Merging
      - Is it likely in the bikes enviornment?
      - Even Forbes has multiple lanes

2 Points For Review

- Use a small set of better range/light resistant sensors (multiple on side might still solve about problem)
  - Can get more data back from certain directions more often
  - Maybe mix of longer range LIDAR/shorter range ultrasonic
- More sensor focus to left rear than right rear since bike likely to be on right side of road

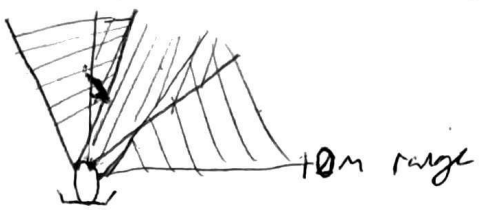
RPLIDAR SETUP

—RPLIDAR ~ $100



ULTRASONIC ×3

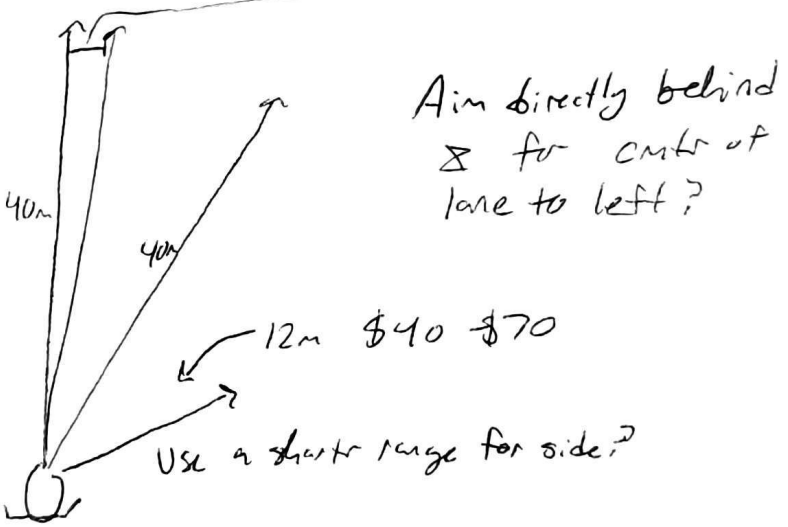
$60 each – $180 total



LIDAR

40m – $110 each – ~~300~~ 3° FOV @ 40m – 2.09m

2× $220



Aim directly behind ⧖ for center of lane to left?

About $300 total

Use a shorter range for side?

Maybe combine w/ Ultrasonic – is this a budget issue?

– Could maybe use only two ultrasonic.

Prof Presentation notes, maybe put 40m lidar on a custom motor of some sort?

- How much would a motor cost?
- How accurate do we need to be w/ returning to previous look directions?
  - Can probably afford to be a little off, but not too much
- How accurate do we need to be on angular separation of different look directions?
  - Probably don't want to skip one, but slight variation might be allowable

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CONCERNED ABOUT NEEDING TO STOP ROTATION W/ SENSORS GETTING 1000 points per second / knowing exactly what information to consider if moving distorts other information.
