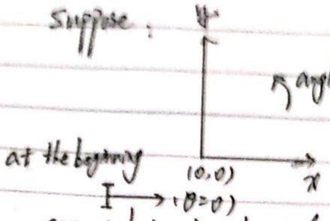
Homework1

For the homeword, I designed the algorithm on the paper, so I attached the images here.

CSE276A.

x	y	angle
0	0	0
-1	0	0
-1	1	1.57
-2	1	0
-2	2	-1.57
-1	1	-0.78
0	0	0

Suppose:



is the world frame for this task.

our robot is located at the origin and the orientation is same as the direction of axis x. ($\theta \to 0$)

Using the bicycle model of the four-wheels car, we could get the $\dot{x}$, $\dot{y}$ and $\dot{\theta}$ as follows:

$$\begin{bmatrix}\dot{x}\\ \dot{y}\\ \dot{\theta}\end{bmatrix} = \begin{bmatrix}\cos\theta & 0\\ \sin\theta & 0\\ 0 & 1\end{bmatrix}\begin{pmatrix}v\\ w\end{pmatrix}.$$

and the turning angle for the front wheels γ is:

$$\gamma = \tan^{-1}\frac{w \cdot L}{v}$$ (L is the distance between front and back wheels)

Then, we use polar coordinate to measure the distance and angle between the ~~goal~~ goal position and the current position.

$$\begin{cases}\rho = \sqrt{\Delta x^2 + \Delta y^2}\\ \alpha = \tan^{-1}\frac{\Delta y}{\Delta x} - \theta\\ \beta = -\theta - \alpha + \beta^*\end{cases}$$

(β^* is the angle of the next point

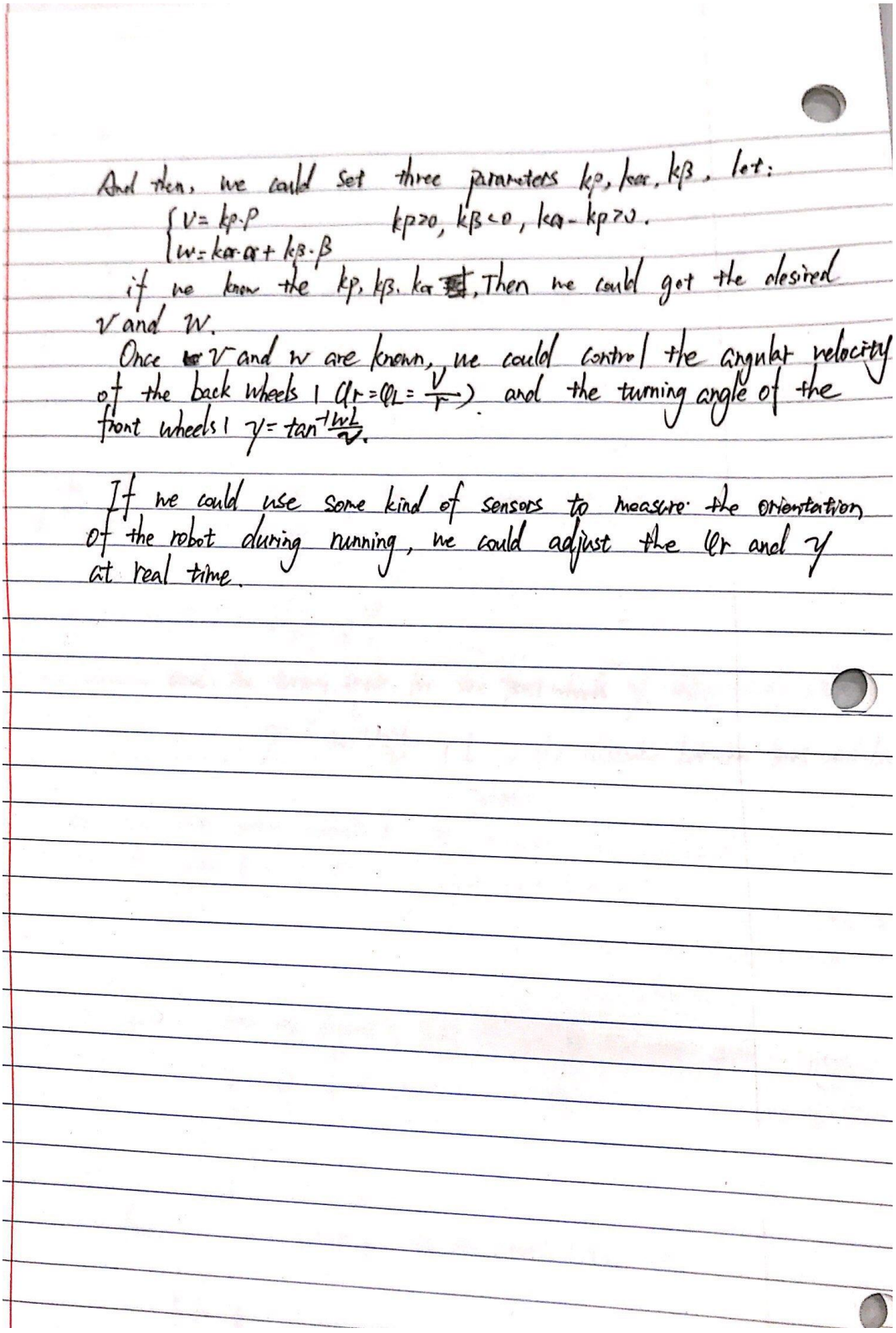
θ is the angle between the robot orientation and the x axis

For example, from the beginning point (0,0,0) to the next point (-1,0,0), θ is equal to 0 and Δx is -1, Δy is 0, α is 0. β is 0.

$$\begin{cases}\theta = 0\\ \rho = 1\\ \alpha = 0\\ \beta = 0.\end{cases}$$

from the point (-1,0,0) to the point (-1,1,1.57)

$$\begin{cases}\theta = 0\\ \rho = 1\\ \alpha = \frac{\pi}{2}\\ \beta = -\frac{\pi}{2} + \frac{\pi}{2} = 0.\end{cases}$$



To illustrate the performance of my algorithm, I used MATLAB for simulation and I put the video and the m file in the zip file which shows the results. In this case, the control parameters are as follows:

kp=0.08;

ka=0.09;
kb=-0.11;

When I run the algorithm in python on the PiCar platform, I find for open-loop control system, I could not adjust the turning angles in real time. Hence, I just designed a open-loop control system for PiCar to pass through all the points as required. From the video, you can see that the car has successfully passed through all the points. Besides, I attach the python code in the zip file.