ECED 6640.03 Mobile Robotics

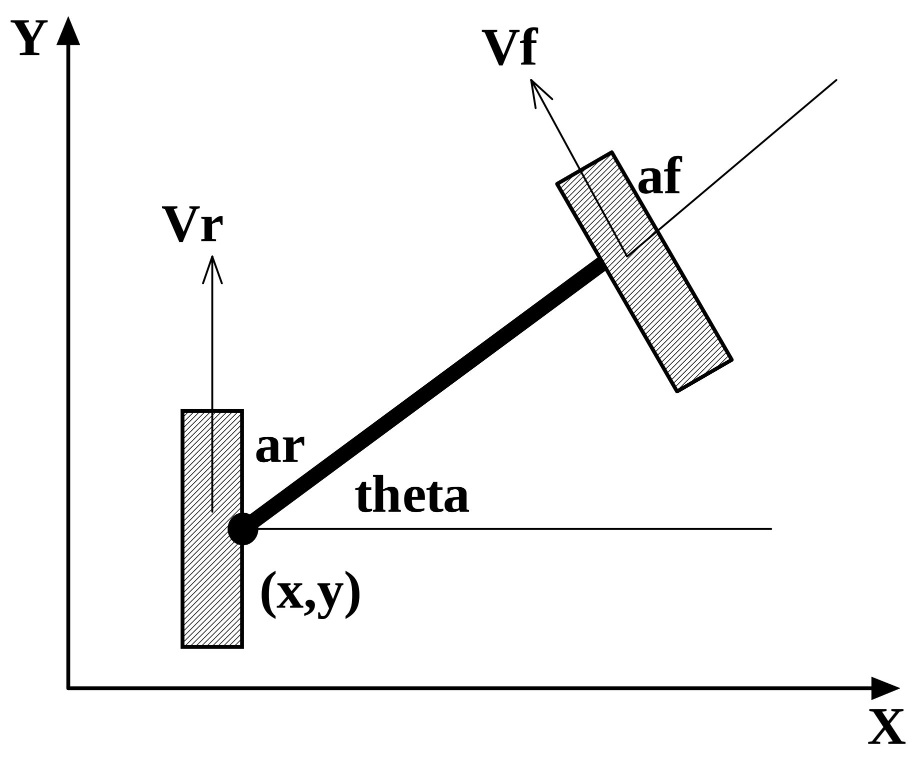
Assignment #2

Http://myweb.dal.ca/~jgu/6640/assignments.html

Due date: In two weeks.

Assignment #2 contains the following problems:

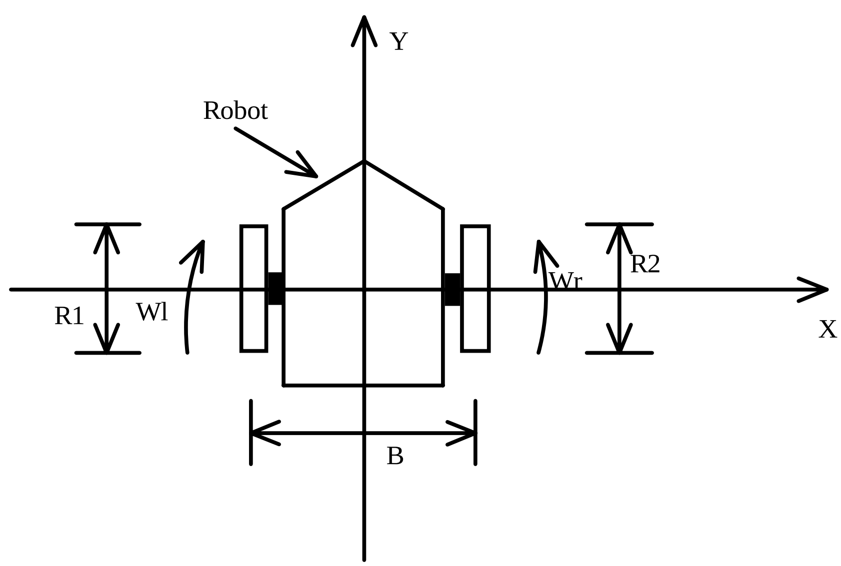
1) Consider the two-steerable-wheeled bicycle sketched in figure 2.1. This is a bicycle in which the front wheel is powered, whereas the rear wheel just rolls on the ground. The front wheel makes an angle a_f with respect to the bike frame, and the rear wheel makes an angle a_r. The front wheel is powered with ground contact speed v_f, and the rear wheel rolls on the ground with ground contact v_r.
    a. If the steering axle of the bike's rear wheel is located at (x, y) and bike's frame points in direction theta as shown in the figure, identify the location of the instantaneous center of the curvature (ICC) for this vehicle.
    b. Under what condition does the ICC exist?
    c. At what speed does the rear wheel need to revolve in order for all of the wheels to roll smoothly on the ground surface?



2) A mobile robot is facing Y direction. Where B is the distance along the axle between the centers of the two wheels. R1 and R2 are the radius of the two wheels. Wl and Wr are the angular rate of the two wheels. Assume the robot starts from the origin. All the numerical values of the parameters are following:

B=20cm,
R1=5cm,
R2=6cm,
W1=5sin(3t)
W2=4sin(3t+1)

Use Matlab write a simulation file to find out the robot's position and ICC from 0 to 10 seconds.
Print out the path of ICC and robot position together in one figure.



3) A vector ^{A}P is rotated about Y_A by 30 degrees and is subsequently rotated about X_A by 45 degrees. Give the rotation matrix, which accomplishes these rotations in the given order.

4) A vector must be mapped through three rotation matrices:

$$^{A}P = {}^{A}_{B}R \, {}^{B}_{C}R \, {}^{C}_{D}R \, {}^{D}P$$

One choice is to first multiply the three rotation matrices together, to form ${}^{A}_{D}R$ in the expression:

$$^{A}P = {}^{A}_{D}R \, {}^{D}P$$

Another choice is to transform the vector through the matrices one at a time; that is,

$$^{A}P = {}^{A}_{B}R\, {}^{B}_{C}R\, {}^{C}_{D}R\, {}^{D}P$$

$$^{A}P = {}^{A}_{B}R\, {}^{B}_{C}R\, {}^{C}P$$

$$^{A}P = {}^{A}_{B}R\, {}^{B}P$$

$$^{A}P = {}^{A}P$$

Because DP is changing at 100 Hz, we must recalculate AP at this rate. However, the three rotation matrices are also changing as determined by a vision system, which gives us new values for ${}^{A}_{B}R$, ${}^{B}_{C}R$, and ${}^{C}_{D}R$ at 30 Hz. What is the best way to organize the computation to minimize the calculation effort (multiplications and additions)?

5) Compute the kinematics (transformation matrix) of the planar arm shown in figure.