Modeling and Simulation

Assignment: Pure Pursuit Problem

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Q1. Implement Pure Pursuit Problem in any language you have been taught during your MCA program.

I. Code of the program

```
#!/usr/bin/env python3
import math

def pure_pursuit_simulation(x_fighter, y_fighter, x_bomber, y_bomber, VELOCITY_FIGHTER, MAX_TIME, MAX_RANGE):
    t = 0
    while t < 12:
        distance = math.sqrt(((x_bomber[t] - x_fighter[t])**2) + ((y_bomber[t] - y_fighter[t])**2))
        print('x_f :', '{:.2f}'.format(x_fighter[t]), ',y_f :', '{:.2f}'.format(y_fighter[t]), end = "")
        print('\tx_b :', '{:.2f}'.format(x_bomber[t]), ',y_b :', '{:.2f}'.format(y_bomber[t]), end = "")
        print('\tDistance :', '{:.2f}'.format(distance),'KMS', end = "")
        print('\tTime : ', t)

        if distance <= MAX_RANGE:
            break;
        x_fighter[t + 1] = x_fighter[t] + VELOCITY_FIGHTER * ((x_bomber[t] - x_fighter[t]) / distance)
        y_fighter[t + 1] = y_fighter[t] + VELOCITY_FIGHTER * ((y_bomber[t] - y_fighter[t]) / distance)
        t += 1
    if t < 12:
        print('\nBomber Destroyed At Time =', t, ', Distance= ', '{:.2f}'.format(distance), 'kms')
    else:
        print('\nBomber Escaped...')

MAX_TIME = 12   # MAX Time To Attack Bomber
MAX_RANGE = 10  # MAX Distance Fighter Can Attack
```

VELOCITY_FIGHTER = 20 # Velocity of Fighter

# Bomber path
x_bomber = [80, 90, 99, 108, 116, 125, 133, 141, 151, 160, 169, 179, 180]
y_bomber = [0, -2, -5, -9, -15, -18, -23, -29, -28, -25, -21,-20, -17]

# Initial Position of Fighter
x_fighter = [0] * 12
y_fighter = [0] * 12

x_fighter[0] = 0
y_fighter[0] = 50

pure_pursuit_simulation(x_fighter, y_fighter, x_bomber, y_bomber, VELOCITY_FIGHTER, MAX_TIME, MAX_RANGE)

II. Results

```
PurePursuitProblem.py
x_f : 0.00 ,y_f : 50.00 x_b : 80.00 ,y_b : 0.00 Distance : 94.34 KMS    Time :  0
x_f : 16.96 ,y_f : 39.40       x_b : 90.00 ,y_b : -2.00       Distance : 83.96 KMS    Time :  1
x_f : 34.36 ,y_f : 29.54       x_b : 99.00 ,y_b : -5.00       Distance : 73.29 KMS    Time :  2
x_f : 52.00 ,y_f : 20.11       x_b : 108.00 ,y_b : -9.00      Distance : 63.12 KMS    Time :  3
x_f : 69.74 ,y_f : 10.89       x_b : 116.00 ,y_b : -15.00     Distance : 53.01 KMS    Time :  4
x_f : 87.20 ,y_f : 1.12 x_b : 125.00 ,y_b : -18.00     Distance : 42.36 KMS    Time :  5
x_f : 105.04 ,y_f : -7.91      x_b : 133.00 ,y_b : -23.00     Distance : 31.77 KMS    Time :  6
x_f : 122.64 ,y_f : -17.41     x_b : 141.00 ,y_b : -29.00     Distance : 21.71 KMS    Time :  7
x_f : 139.55 ,y_f : -28.09     x_b : 151.00 ,y_b : -28.00     Distance : 11.45 KMS    Time :  8
x_f : 159.55 ,y_f : -27.94     x_b : 160.00 ,y_b : -25.00     Distance : 2.97 KMS     Time :  9

Bomber Destroyed By Fighter At Time = 9 & Distance=  2.968957770109932 kms
```

III. Discussion, if any

- Pure pursuit is a type of pursuit curve used in aerial combat in which an aircraft pursues another aircraft by pointing its nose directly towards it.
- Pure Pursuit: When target is not aware of pursuer. In this case the course of target is known.
- Hot Pursuit: When target is aware of the pursuer.
- A fighter aircraft sights an enemy bomber and flies directly towards it in order to catch up the bomber and destroys it.
- The bomber continues flying so that the fighter has to change its direction to keep pointed towards the target.
- If the target flies along a straight, the problem can be solved directly with analytical techniques.

We are given following conditions:

1. Both target and pursuer are flying in the same 2 dimensional plane.
2. The fighter's speed is constant that is VELOCITY_FIGHTER.
3. The target's path is known.
4. Minimum distance required by the fighter to fire a missile at bomber is 10 units.
5. If the target is not caught within given time t (here t = 12), the target(bomber) escapes.
6. Initial coordinates of the pursuer (fighter) are known.

On Sumulating we found fighter hits Missile at bomber at time = 9, and distance = 2.96kms