Course No. – AS 5570

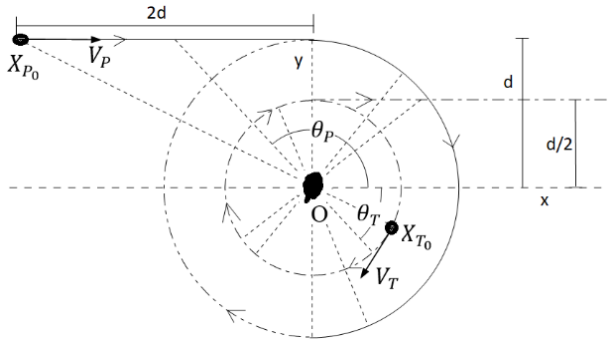
Principles of Guidance for Autonomous Vehicles

Assignment 3 **Due Date: October 3, 2024**

(For Computer Assignments: Oct 10, 2024)

Part A : Line-Of-Sight (LOS) Guidance

1) Consider an engagement between a police 'P' and a thief 'T'. Their initial locations are $X_{P_0} = (-2d, d)$ and $X_{T_0} = (\frac{d}{2}\cos\phi, \frac{d}{2}\sin\phi)$, where $\phi = -\sin^{-1}(\frac{1}{\sqrt{5}})$. [**Note:** At this location P and T cannot see each other because of the tree 'O' (serves as the origin in the inertial reference frame, see the figure)]. (Angles are considered positive CCW.)



However, from prior movement of the thief, the police realizes that the thief is hiding behind the tree 'O' (see the figure), the police starts following sequences of movement with constant speed V_P at the following three phases. And, the thief always attempts to maintain his position such that the police cannot see him because of the tree 'O'.

Phase 1: In this phase, P starts from initial location $(-2d, d)$ and reaches $(0, d)$ without any turning. During this time, T maintains same distance $\frac{d}{2}$ from the tree O and keeps on turning such that P cannot see T.

Phase 2: In this phase, P initiates and continues a clockwise turn surrounding the tree 'O' with fixed radius $'d'$ and reaches $(0, -d)$. During this time also, T maintains same distance $\frac{d}{2}$ from the tree O and keeps on turning such that P cannot see T.

Phase 3: In this phase, P continues the clockwise turn surrounding the tree 'O' with fixed radius $'d'$. During this time, T initiates a run-away motion along the straight line $y = \frac{d}{2}$ without any turn such that P cannot see T.

i. At which times Phase 1 and Phase 2 end?

ii. For each phase, obtain the expressions of $\theta_P(t)$ and $\dot{\theta}_P(t)$ in terms of V_P and d.

iii. For each phase, obtain the expressions of $V_T(t)$ and $\dot{V}_T(t)$ in terms of V_P and d.

iv. Draw schematic plots of $\theta_P(t)$ and $V_T(t)$.

Part B : TPN and RTPN Guidance

1) Derive the conditions for successful capture of a maneuvering target ($a_T = \frac{b}{V_\theta}, b > 0$) by TPN ($a_P = -N' V_{R_0} \dot{\theta}$).

2) Derive the conditions for successful capture of a maneuvering target ($a_T = \frac{b}{V_\theta}, b < 0$) by TPN ($a_P = -N' V_{R_0} \dot{\theta}$).

3) Problems 1 and 2 on Page 173-174 of NPTEL lecture series on TPN and RTPN.

   (1(b), 1(c), 2(b), 2(c) – **Computer assignment**)