ICE - Inverse Trigonometry

Figure 1: Scene over Bghdad, Iraq, during the first few days of the air attacks that preceded Operation Desert Storm. The bright spots are tracer rounds from Iraqi anti-aircraft guns.

You are no doubt familiar with the scenes from Operation Desert Storm which showed glowing columns of anti-aircraft fire rising from the city of Baghdad (see Figure 1[1]).

Hitting a moving target with a projectile weapon is not an easy task, as you need to take both the distance between you and the target and the movement of the target into account.

Instead of firing directly at a moving target, you need to fire slightly ahead of the target. Figure 2 shows the screen from an air-to-air combat simulator. In this simulator (used to train US Air Force fighter pilots) a small cross shows the pilot where to fire the cannon. The cross shows that the pilot should fire a little ahead of the enemy aircraft because during the time it will take for the cannon shells to reach the enemy, the enemy will have moved forward a little.

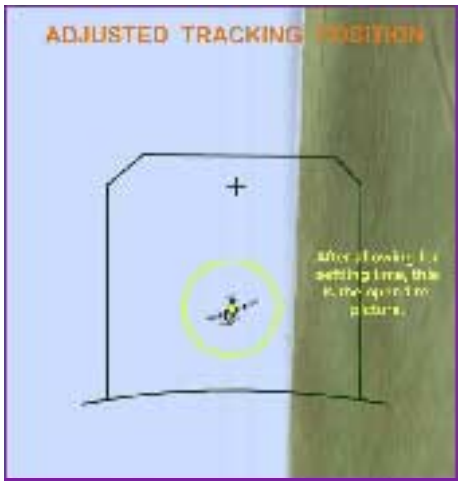

Figure 2: Scene from an air-to-air combat simulator. The enemy aircraft is enclosed by a circle. The small cross near the top of the screen shows the pilot where to aim in order to hit the enemy aircraft. Note that this is not directly at the aircraft.

In this ICE you will recall some of the calculations that you did as part of your last lab in Math Xa ("Resource Wars"). Specifically, you will model a situation in which a gunner is attempting to hit a moving target and calculate where the gunner should aim in order to hit.

[1] Image source: http://www.cnn.com/

• ***Figure 3 (below) shows the situation for an anti-tank gunner attempting to hit a moving tank. Assume that the tank moves with a velocity of v_1 and the projectile from the anti-tank gun will move with a velocity of v_2. Calculate L, the distance that the gunner should aim ahead of the tank.***

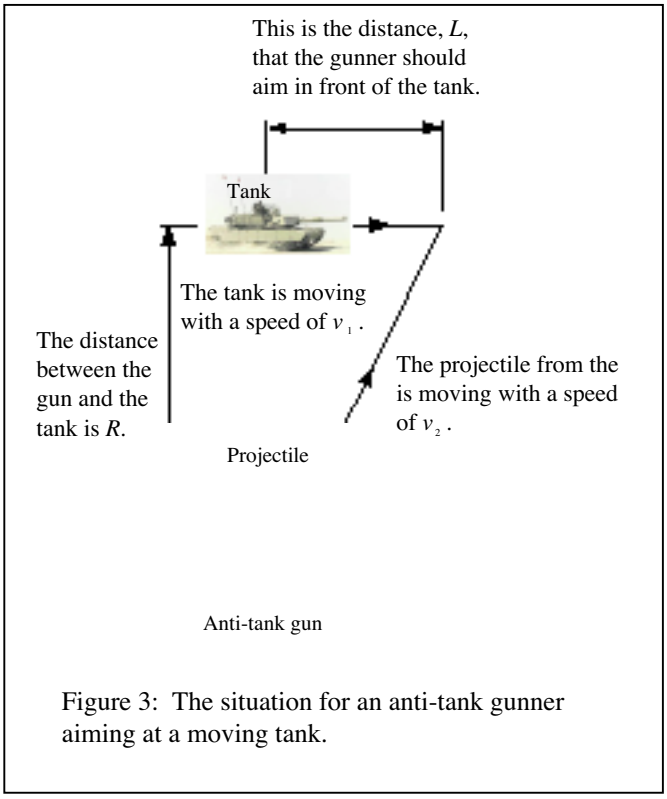

Figure 3: The situation for an anti-tank gunner aiming at a moving tank.

• ***Table 2 (see below) gives the velocities for a toy tank and a NERF projectile (see Figure 4[2]). Use these values to calculate the angle that a gunner should turn in order to hit the tank as it passes.***

Moving object	Symbol from Figure 3	Numerical value (meters per second)
Tank	v_1	0.35
Projectile	v_2	5.25

Table 2: Velocity data for toy tank and NERF projectile.

Figure 4: The anti-tank gun.

[2] Photo credit: Oliver Knill, Department of Mathematics, Harvard University, Cambridge, MA 02138.