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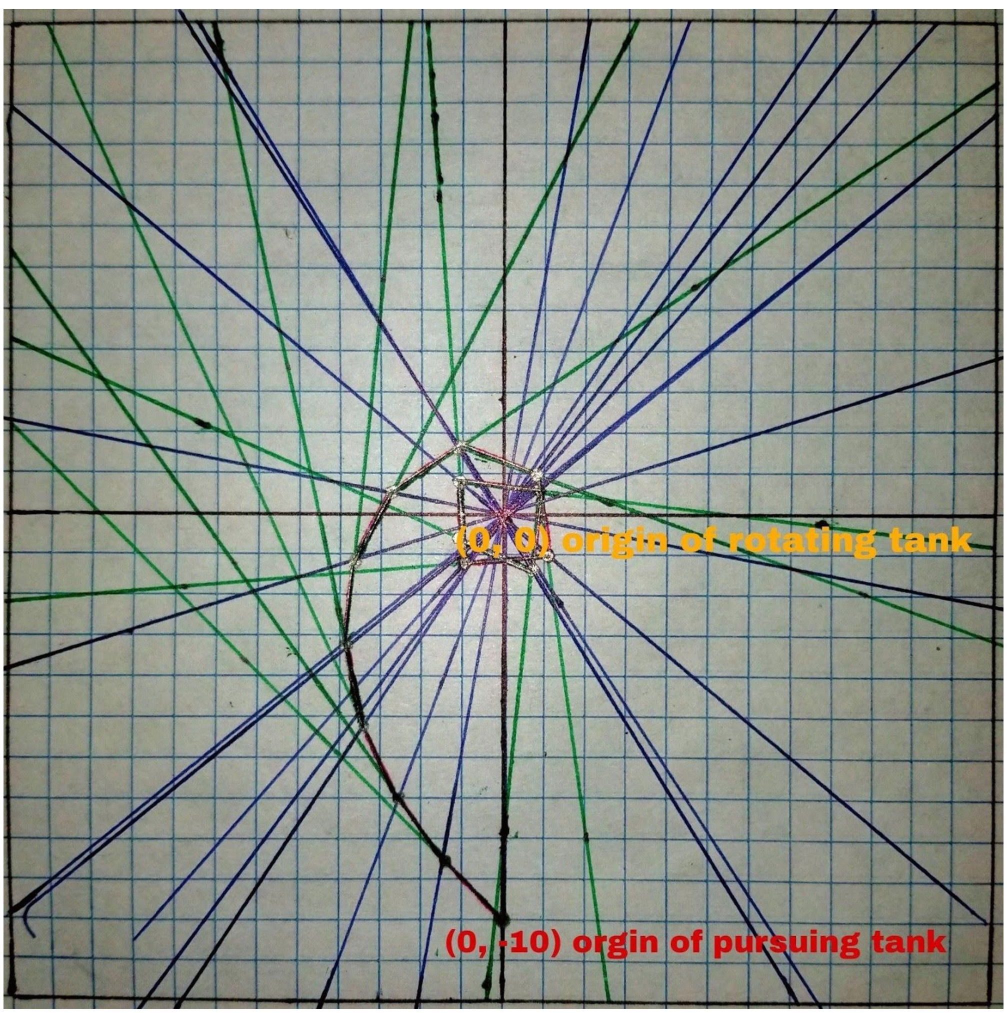
Dynamic Aiming Final Project

The project that we were assigned is part of the dynamical aiming section. The question that was posed is "How would two tanks with broken turrets battle if they try to shoot at each other at all times?" For this project, we will assume that the turrets cannot move on the horizontal or vertical axis. To limit the possibilities, we will also assume that the turret is positioned in a horizontal fashion parallel to the ground and that the tanks are battling in an open and flat field. We will also rely on the fact that tanks can rotate by spinning their tracks in opposite directions and limit the movement of one tank to be stationary to allow easier computations to be done. If we narrow the possible orientations of the barrel of the turret relative to the front or rear of the tank to 0° (facing forwards or backwards), 45° (diagonally over the tack and directly over the corner), and 90° (straight off one of the sides), this would give a total of three possible battle scenarios: one where the turret is locked at 0°, one where the turret is locked at 90°, and one where the turret is locked at 45°. To show how these different scenarios would play out, we will make use of Excel to plot the most logical courses the respective tank would need to take during the battle to remain aimed at the other despite their inability to reposition the turret. For future references for the project we will refer to the stationary tank as ‘Tank S’ and the pursuing tank as ‘Tank P’.

To start off with we began by drawing out a model path for Tank P on graphing paper using a protractor and different colored pens. The Green color represents the direction of motion of Tank P with respect to the turret being aimed at the stationary tank. The blue color represents the direction the turret is facing at each point before Tank P begins to move again. The tank will always have the turret facing at 45 degrees towards Tank S marked at the origin. We have determined that the path Tank P will take as it moves towards Tank S will end up making a spiral-like motion. As Tank P moves keeping the turret locked on Tank S it will gradually get closer and closer to Tank S.



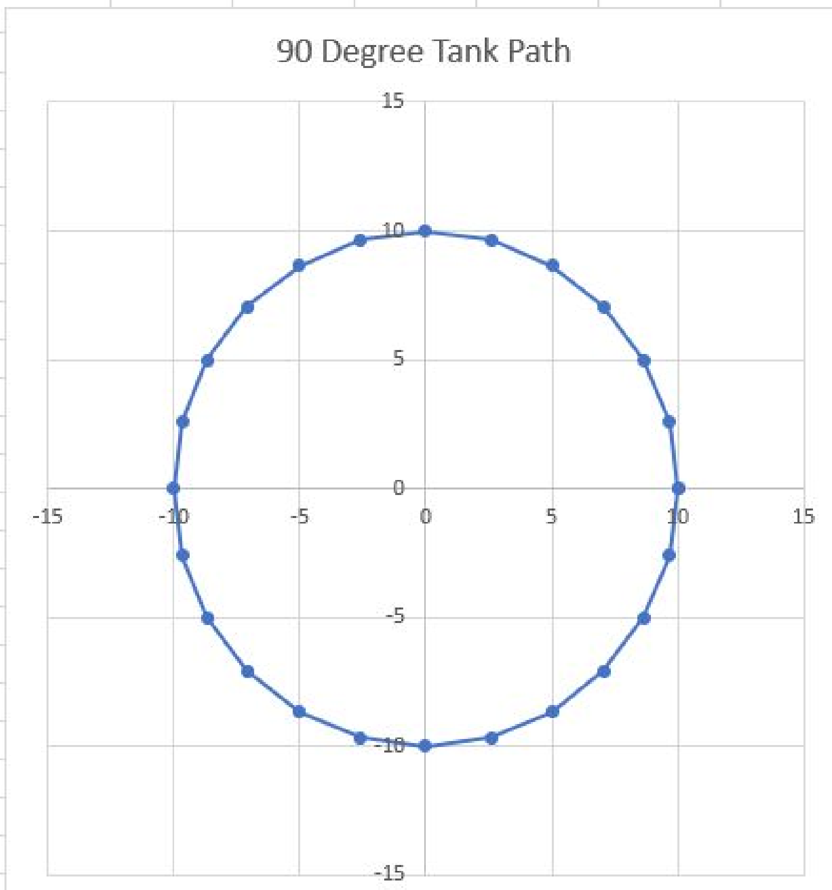
We have represented this by starting Tank P at (0, -10) moving at a 45° angle as it travels up one unit and left one unit to the point (-1, -9). From this we were able to determine the distance that the tank would move to be 1.41 units by using the distance formula d=sqrt((x2-x1)^2+(y2-y1)^2). We then used this value to be the increment by which the tank would move before rotating again to allow the turret of Tank P to face Tank S. Since we know that the tank will always have a 45 degree angle between Tank S and Tank P we then used the law of cosines to show how the distance between the two tanks decreases in a path that allows Tank P to move closer to Tank S. The equation that we used was d=sqrt(1.41^2+10^2-2*1.41*10*cos(45)). This will then show the new distance the tanks are apart from each other. From here you can repeat the equation substituting the new distance value for the previous value. This is easily repeatable in Excel since the degree will always be at 45 and the distance it will travel will be 1.41 units.

=SQRT(I2^2+$G2^2-2*$I$2*$G2*K3)

D	E	F	G	H	I	J	K
		Position	Distance between Tanks (D)		Distance Traveled by Tank		
		1	10		1.414213562	sin 45	cos45
		2	9.055385138			0.707107	0.707107
		3	8.117218103				
		4	7.187126931				
		5	6.267418899				
		6	5.361501829				
		7	4.474672971				
		8	3.615709095				
		9	2.800345348				
		10	2.059427924				
		11	1.456841627				
		12	1.099410875				
		13	1.004929113				
		14	1.000012148				

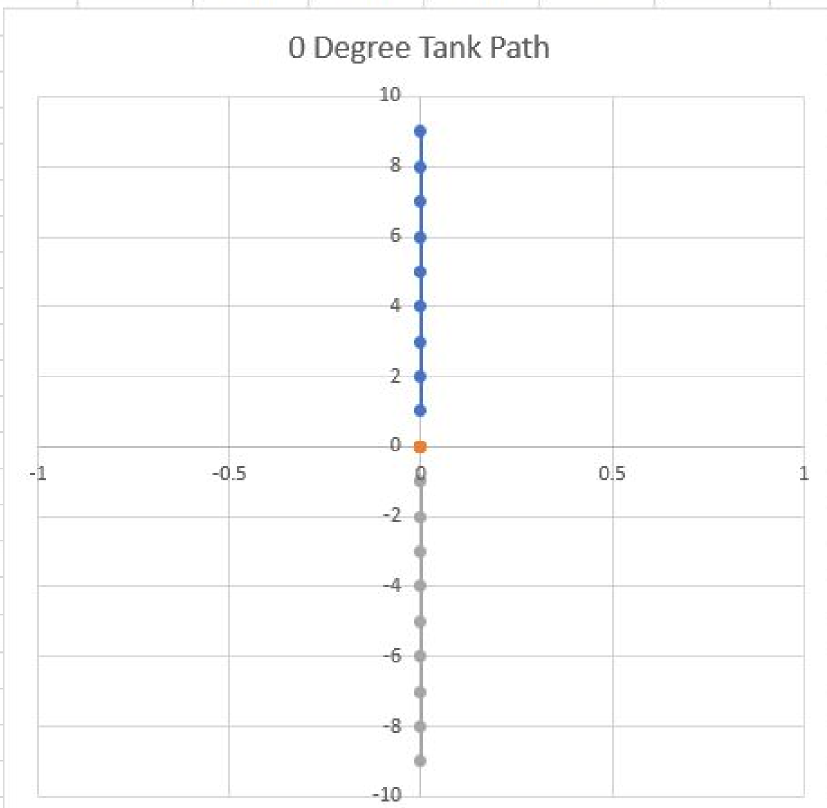
For the 90 degree turret it is easy to model this since the tank will have to travel in a fashion similar to a circle. We modeled this by creating a circle in Excel using the equations $x = r*\cos(\theta)+x_0$ where r is the radius, θ is the degree in radians and x_0 the value of x at the origin and $y=r*\sin(\theta)+y_0$ where r is the radius, θ is the degree in radians and y_0 the value of y at the origin.

P	Q	R
	r=	10
	x_0=	0
	y_0=	0
Angle (deg)	x	y
0	10	0
15	9.65926	2.58819
30	8.66025	5
45	7.07107	7.071068
60	5	8.660254
75	2.58819	9.659258
90	6.1E-16	10
105	-2.5882	9.659258
120	-5	8.660254
135	-7.0711	7.071068
150	-8.6603	5
165	-9.6593	2.58819
180	-10	1.23E-15
195	-9.6593	-2.58819
210	-8.6603	-5
225	-7.0711	-7.07107
240	-5	-8.66025
255	-2.5882	-9.65926
270	-2E-15	-10
285	2.58819	-9.65926
300	5	-8.66025
315	7.07107	-7.07107
330	8.66025	-5
345	9.65926	-2.58819
360	10	-2.5E-15



For the turrets stuck at 0° the only possibilities for the motion of them would be to move forwards or back, otherwise they would not be facing each other. We modeled this on Excel by showing both tanks at separate ends (0,10) and (0,-10) moving towards the origin.

Tank 1		Tank2	
x	y	x	y
0	10	0	-10
0	9	0	-9
0	8	0	-8
0	7	0	-7
0	6	0	-6
0	5	0	-5
0	4	0	-4
0	3	0	-3
0	2	0	-2
0	1	0	-1



In conclusion, it appears that your odds of surviving these unfortunate scenarios would be greatest if the turret of your tank were stuck at 90° and your opponent rotated on the same spot. This would give you maximum distance while still allowing you you to be aimed at the target. In contrast, if your turret were locked at 45°, you would end up very close to your opponent and would each be shooting at point blank until you collided. If both turrets were locked at 0°, you would each have a straight shot. For this, you may want to consider a strategy involving retreat.

Works cited

Distance formula

http://www.mathwarehouse.com/algebra/distance_formula/index.php

Side Angle Side Theorem

http://www.teacherschoice.com.au/maths_library/trigonometry/solve_trig_sas.htm