Trigonometric Identities
Lake Project
Tucker High School STEM Program

Overview

In today's society, drones and flying cameras have become a way of life in terms of security, monitoring, recreational use, and topographical studies conducted through the air and sea. Drones will only continue to grow in our everyday lives as time goes on. For this project, teams of two to three students will utilize their knowledge of trigonometric identities, graphical analysis, geometric properties, and scale modeling to develop a device that will assist the user of a drone to take the most efficient picture of the entire Kelley Cofer Lake in one shot from the center point of the lake.

Requirements

Students must design and build an eco-friendly prototype that must be used from the shore and that will consist of repurposed materials. It will be used to identify the centerpoint of Kelley Cofer Lake **AND** visually get the drone to the correct height to take one aerial picture of the lake.

Initially, students will only be given a set of multiple different trigonometric identity-based problems and from these they must determine:

A. The maximum viewing angle (photographic angle) of the camera on the drone
B. The geometric shape used to determine the centerpoint of the lake
C. The **BEST** shape used to determine the centerpoint of the lake that also generates the most efficient (lowest) height at which the drone can take a picture of the entire lake
D. The centerpoint of the lake
E. The height of the drone at the assumed centerpoint of the lake
F. Finally, students must use a trigonometric proof to defend what they believe the best geometric shape that identifies the lake's center point and the lowest possible height for the camera to take a picture of the lake in one shot

After determining all of the above, students will utilize the Engineering Design Process to design the prototype of a device that will allow a user from the shore to determine the centerpoint of the lake **AND** the appropriate height of the drone.

Students must deliver the following items:

A. Detailed technical drawings of their device
B. List of repurposed materials, none of the materials can be purchased except for any fasteners needed
C. A reason/defense (½ page minimum) as to why this device will work
D. A detailed testing protocol and data from the tests that yield positive results or refinements needed to the device

THE TASK:

1. Estimate the viewing angle of the drone's downward-facing camera

We know that, when looking up at the drone from the edge of the lake:

The *ratio* of the height of the drone above the water to the horizontal distance to the drone

is equal to

The difference of:

two times the square of the ratio of the horizontal distance to the drone and the distance between the observer and the drone

and

the ratio of the horizontal distance to the drone over the distance between the observer and the drone at twice the observer's viewing angle

Create a diagram showing the lake, the observer, and the drone. Then, set up a trigonometric equation to determine the viewing angle of the person on the ground and the **total** viewing angle of the drone's downward-facing camera.

2. Determine the geometric center of the lake.

Determine the best figure to use to approximate the shape of the lake. Demonstrate on the lake diagram provided.

Determine the geometric center of the figure found above.

3. Determine the height at which the drone must hover over the center of the lake in order to capture the entire lake with its camera.