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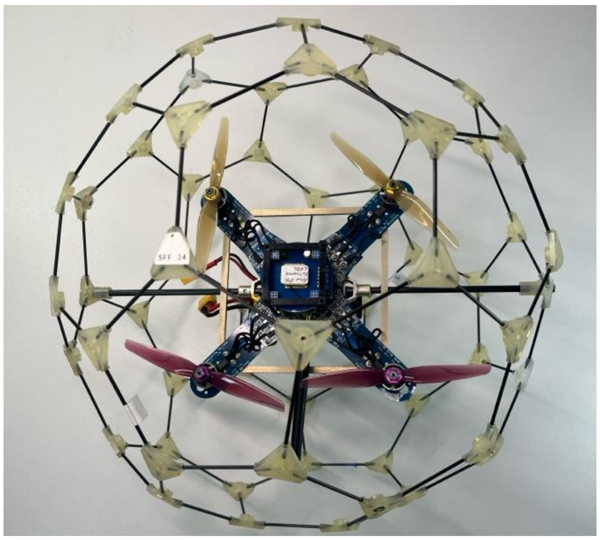
Flight Basket Geometry

Purpose:

Truncated icosahedrons, the bucky ball, have a unique geometry that can provide a protective sphere for drones. Currently, Kairos Autonomi only offers one size of flight basket for drones of this size, no more than 13" in diameter. This document provides a methodology to accommodate different-sized drones. This is done by gaining an understanding how changing diameters affect the edge length and angles used in the molds used for making a bucky ball.



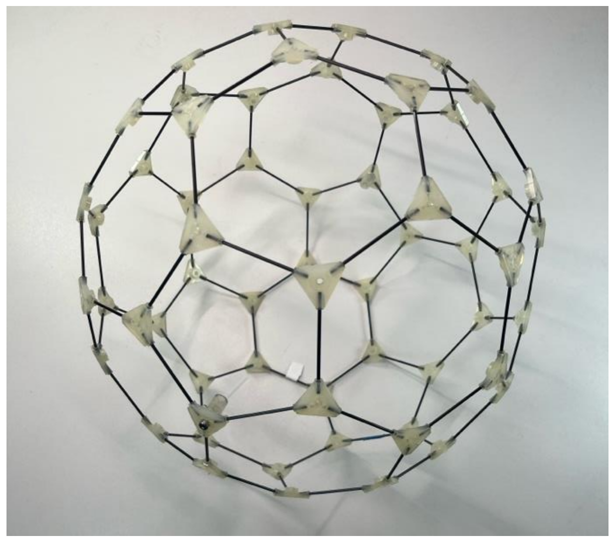


Figure 1: The flight basket with and without a drone.

Redefining the Problem:

Truncated icosahedrons do not have a diameter in the traditional sense. The term "diameter" is convenient but inaccurate when describing the geometric properties of a truncated icosahedron. Instead, we use the concept of the mid-radius. To better explain this, imagine placing a sphere that fits perfectly inside a cube box—the mid-sphere. Conversely, there is the circum-sphere, a sphere into which you can fit the entire box. For our purpose of fitting objects inside these truncated icosahedrons, we need to understand the mid-sphere, which allows us to determine the diameter from its radius. The radius of the mid-sphere is known as the mid-radius or interradius.

Solution:

Since the vertices of truncated icosahedrons are all the same length, we can find the mid-radius using the formula: $r_m = \frac{3}{4} * a * (1 + \sqrt{5})$, where r_m is the mid-radius, and a is the edge length. By doubling the mid-radius, we can find the diameter of the sphere that would fit inside the truncated icosahedron. This formula can be simplified down to the following relationship between Diameter of the Mid-sphere (D_m) and edge length: D_m = a*4.85410197.

To solve for the edge length (a) when the desired diameter is known, use the formula: $a = \frac{2}{3} * \frac{r_m}{1+\sqrt{5}}$ Which can be simplified down to a = D_m *0.20601133. This is the exact inverse of the other formula.

Example 1	Example 2	Example 3
Diameter: 60”	Edge length: 2.75”	Diameter: 74”
Edge length: ?”	Diameter: ?”	Edge length: ?”
a=D_m*0.20601133	D_m =a* 4.85410197	a=D_m*0.20601133
a=12.36”	D_m = 13.35”	a=14.83”

Angles:

Further investigation indicates that the mold currently used for the connectors will work for bucky balls of larger sizes. Regular hexagons and regular pentagons have specific angles that make them regular shapes, and altering these angles would result in irregular shapes.

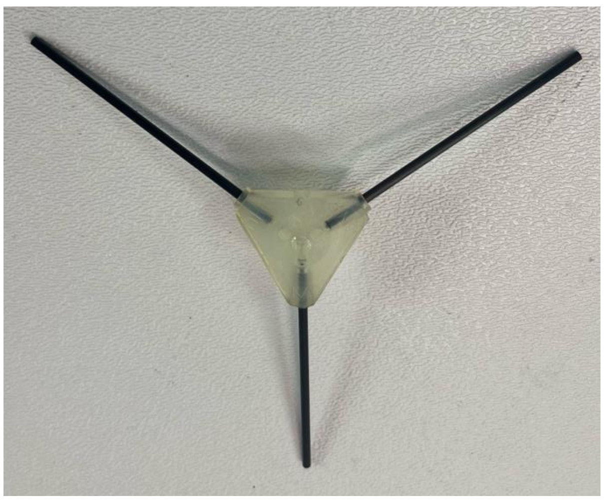


Figure 2: The mold currently used can make larger size flight baskets for larger drones, so long as the edge pieces are strong enough to withstand a crash.

Conclusion:

Understanding the relationship between edge length, diameter, and angles in truncated icosahedrons is essential for designing and producing spheres that can accommodate various sizes of drones. The mid-sphere diameter is going to be about 5 times that of the edge length. The versatility of this unique geometry can be harnessed to provide optimal protection for drones of different dimensions.

References:

https://rechneronline.de/pi/truncated-icosahedron.php

https://www.redcrab-software.com/en/Calculator/Truncated-Icosahedron

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Revisions

Name/Signature	Date	Description
Cameron Miller	07/24/2024	Original version