

Wind tunnel test of the dynamic stability of small unmanned aerial vehicles

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Abstract. The field of unmanned aerial vehicle research is made possible by developments in GPS navigation and wireless controlling systems. Eliminating the human payload allows the size of UAVs to be much smaller than traditional aircraft, and reduces the number of design constraints, allowing a larger number of shapes to be considered. I was able to test a series of full scale models of small UAVs. The models must be able to maintain stability throughout the accelerations that they experience throughout the tests. The movement of the more traditional winglet model had a very high lift rating with a small amount of comparative drag. The half cylinder shape had a pretty low amount of lift, but had an increasingly high amount of drag. From this, I concluded that the preferred shape of a small UAV is similar to a traditional wing, and that a small UAV needs to be flown with low acceleration. Through studies like these, we are able to fly through the skies, without having a human inside.

Keywords: Engineering, Aeronautics, Unmanned Aerial Vehicles

INTRODUCTION

The field of unmanned aerial vehicle research is made possible by developments in GPS navigation and wireless controlling systems. Eliminating the human payload allows the size of UAVs to be much smaller than traditional aircraft, and reduces the number of design constraints, allowing a larger number of shapes to be considered. I was able to test a series of full scale models of small UAVs. The models must be able to maintain stability throughout the accelerations that they experience throughout the tests. The present-day aeronautics field is actively experimenting and studying the new ideas of unmanned aerial vehicles (UAV). This capability stretches from the practical children's toys, to high-tech surveillance and assault crafts created by scientist like John Pike and Andreas Parsch used by militaries all over the world. I have found that even the military forces of this great nation rely heavily on the advancements made in this particularly field. Because of these crafts can be flown remotely, there is no need to waste human life. Because of this, we are able to find new ideas for different more unique shapes. I plan on testing several different shapes and dimensions to find a suitable model that would be an example of a UAV. I will test it on several different ways to see what would fair the best.

METHODS

A spring scale was needed to calibrate the lift and drag meter readings of an aeroSTREAM wind tunnel scanTEK 2000 ST180 AERODYNAMICS MODULE (LJ Created Ltd. Norwich England UK). This was possible through the projecting stand inside the wind tunnel as a sort of stake. From there the hooking end of the scale was attached and forced was exerted upon it. The points were then converted into N by using the formula, $1000g=9.8N$. After, they were converted into mN by multiplying the figures by 1000. The points were then recorded, by sensitivity level, into an Excel spread sheet and a trend line was added. The same was the done for both the winglet structured model, and half-cylinder shape model. From these readings a chart was created to organize my data.

RESULTS

I found that as the voltage reading increased, so to do the force measured in millinewtons. I also found that as sensitivity level increased, so did the millimeters, and number of actual figures recorded. (As seen in Table 1) I also found that the lift for model #1 (Half-cylinder) had a lift of 49 millimeters, a drag of 98 and a lift to drag ratio of 0.50. While model #2 (Winglet) had a lift of 931 millimeters, a drag of 343, and a ratio 2.7. (As seen in FIGURE 1)

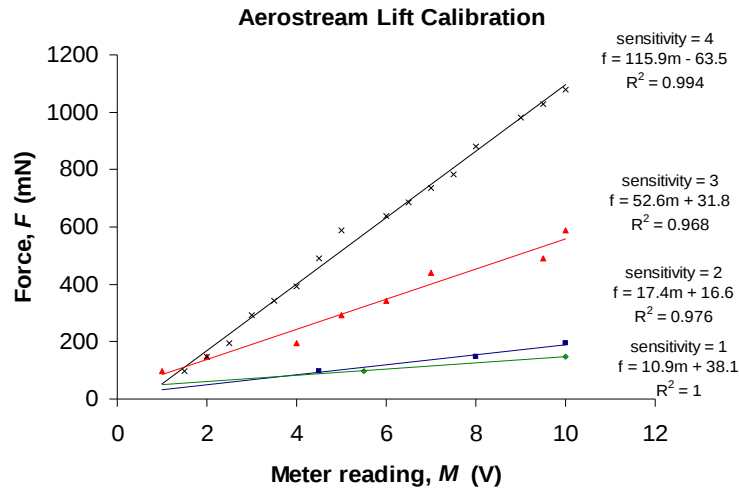


Figure 1: The graph above shows the points of the aeroSTREAM calibrations. These readings were plotted in order from sensitivity level. The left hand part of the graph is the converted millinewton force that was exerted, while the bottom was the meter readings displayed in volts.

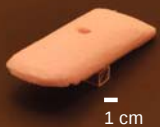
Shape	Lift (mN)	Drag (mN)	Lift to Drag Ratio
	49	98	0.50
	931	343	2.7

Table 1: The chart displays the readings that were recorded from the two models, the half cylinder shape model and the winglet shaped model. From there they were put into millinewtons using the same conversions as the previous figures. These readings were then group into lift and drag columns where a ratio was performed using the data, as seen in the far right columns.

DISCUSSION

I had a few limitations to my science fair project. The wind tunnel I did my testing in was very small. It could only hold up to about 20 and one-half centimeters, and only go up to a high speed of about 40 miles per hour. I also found that the more traditional winglet had a much higher lift to drag ratio than the half-cylinder shape, and mini airplane models. This means that the ideal shape of UAVs are not the conventional thought of planes portrayed in today's toy industries, but a much more aerodynamic wing shapes. This can greatly help the overall shape and structure of flyable regular UAVs in use in the field today.

CONCLUSIONS

I conclude that the preferred shape of a small UAV is similar to a traditional wing. It had a superb lift to drag ratio that would make for the ideal conditions for flight. The more cylinder shaped model was very stable, but had a large amount of Drag, which will not allow flight. This would be a fatal aspect of the model that would result in no flight at all.

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REFERENCES

Andreas Parsch

Current Designations of U.S. Unmanned Military Aerospace Vehicles

<http://www.designation-systems.net/usmilav/missiles.html>

Last updated was: 2008

Accessed: November 7, 2008

editor@sciencedaily.com

<http://www.Unmanned Aerial Vehicles Mark Robotic Antarctic Survey>

sciencedaily.com/release/2008/03/080318100925.htm

Last update was: 2008

Accessed: November 6, 2008

Gil Barid

Engineered Inflatable

http://www.ilcdover.com/products/aerospace_defense/engineeredinflatables.htm

Updated by: Gil Barid

Last update was: 2008

Accessed: November 5, 2008

John Pike

Unmanned Aerial Vehicles (Uavs)-Military Aircraft

<http://www.fas.org/irp/program/collect/uav.htm>

Updated by: Steven Aftergood

Last update was: December 20, 2007

Accessed: October 17, 2008Sudhir C. Merota and Richard White

John Pike

Unmanned Aerial Vehicles (UAVs)

<http://www.globalsecurity.org/intell/system/uav.htm>

Last update was: 2008

Accessed: November 5, 2008

John Pike

Unmanned Combat Air Vehicle (UAV)

<http://www.globalsecurity.org/military/systems/aircraft/ucav.htm>
Last updated was: 2008
Accessed: November 6, 2008

John Pike
Unmanned planes: eyes in sky
<http://www.globalsecurity.org/military/library/news/2004/01/mil-040129-mcn02.htm>
Last update: 2008
Accessed: November 8, 2008

Roland Piquepaille
Unmanned Airplanes for Civilian Usages?
<http://radio.weblogs.com/0105910/2003/04/29.html>
Last update: August 2008
Accessed: November 8, 2008

UAV design guidelines UAV trends UAV design utility
http://www.barnardmicrosystem.com/L4E_UAV_design.htm
Last update was: 2007
Accessed: October 17, 2008

Vigyan-Low Speed Wind Tunnel
<http://www.vigyan.com>
Last update was: June 20, 2007
Accessed: October 15, 2008