Investigating the Effects of Different Types of Winglets on Fixed Wing Aircraft Performance

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INTRODUCTION

Winglets (the small fins on aircraft wingtips) can be found on many of today's aircraft.

The sheer variety of winglet shapes suggests that each has its own unique aerodynamic properties. Perhaps one shape increases cruising speed while another shape reduces fuel consumption. However, certain types of aircraft (e.g. jet fighters) do not have winglets.

It is possible that the tradeoff between maneuverability and fuel efficiency is not satisfactory in these cases.

As mentioned previously, winglets serve a myriad of purposes. In the expanding world of commercial UAVs, winglets can perhaps extend the range of UAVs designed for search and rescue, agriculture, or forestry. Winglet-esque devices could also be used on cars, boats, or submarines to improve fuel efficiency or increase maneuverability.

Research Questions:

1. To discover the potential effects of different types of winglets on RC aircraft speed.
2. To understand how and why winglets cause these effects.
3. To discover the extent of these effects.

Research Methodology:

1. Learn the fundamental physics and mathematics concepts behind fixed wing aircraft flight and design.
2. Learn the how to build a RC aircraft from scratch.
3. Build a "control" RC aircraft that lacks winglets.
4. Build a few different sets of attachable winglets.
5. Fly the aircraft on a non-windy day at the JLS athletic fields according to a predetermined flight plan.
6. Using an onboard GPS, collect the speed of the aircraft at various points along the flight plan.

MATERIALS & METHODS

Materials:

Airframe

- (5) 20 in. x 30 in. x .1875 in. paper-laminated foam board
- (1) 2.375 in. x 2.375 in. x .25 in. piece of balsa wood
- 1/16 inch diameter wire
- (4) small plastic control horns
- Velcro
- (4) long rubber bands
- (2) bamboo skewers, cut into 3.5 inch pieces
- Duct Tape
- Glue (Gorilla, Tacky, and Hot)

Electronics

- (1) Turnigy 9x 9 channel RC Transmitter and Receiver
- (1) SkyRC GSM-010 GPS receiver
- (4) Turnigy TG9e Eco Micro Servos
- (1) 1450kv Outrunner Brushless Electric Motor
- (1) 2150 mAh 3S 11.4V lithium polymer battery
- (1) Hobby King 20-amp electronic speed control

Methods:

1. Design and construct a foam board RC plane and 3 sets of winglets
2. Attach a GPS receiver onto the plane to track airspeed, altitude, etc.
3. Fly the plane on a predetermined flight path 3 times per winglet type
4. Upload data from the GPS onto a computer
5. Analyze the data

THE FINISHED AIRPLANE

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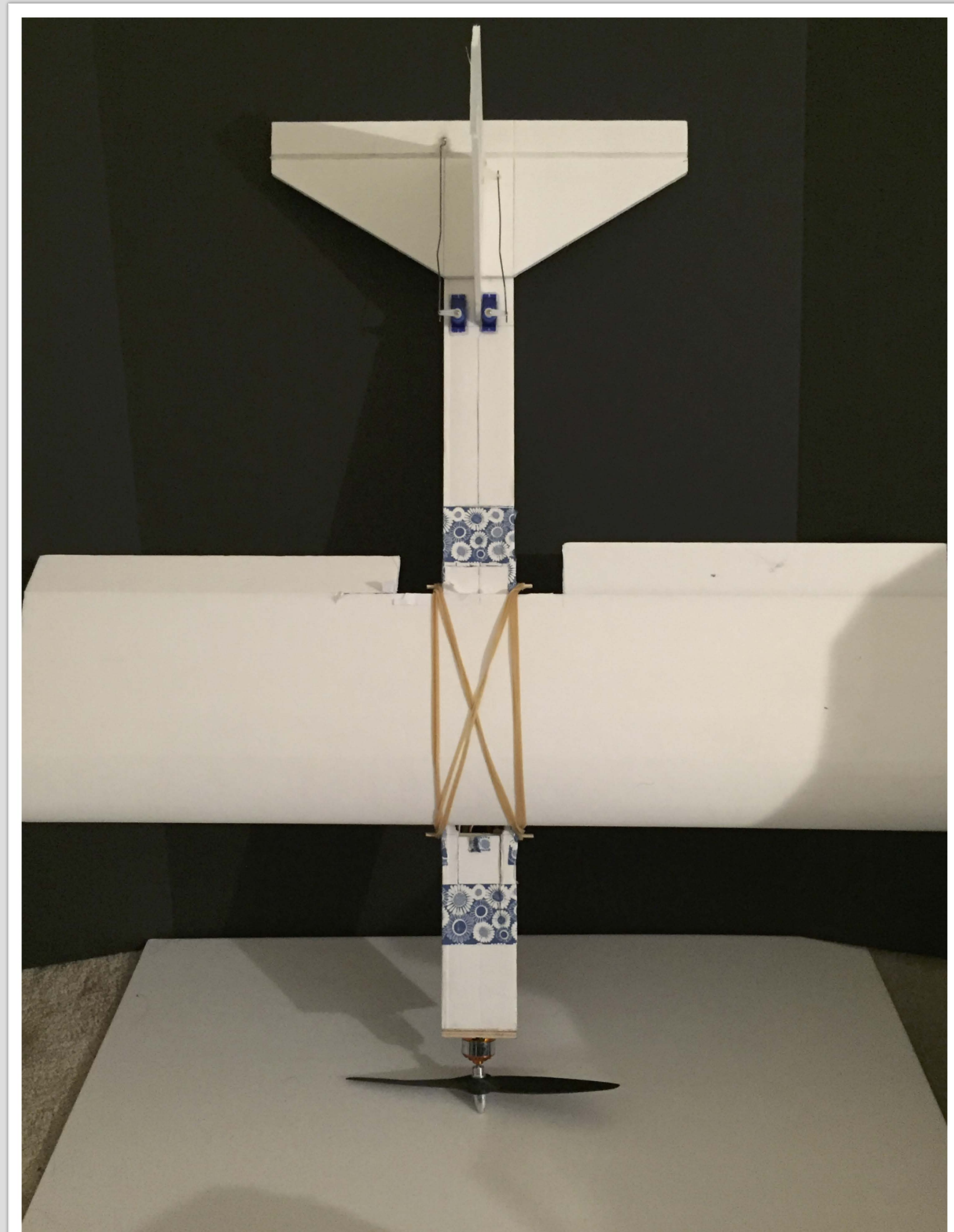


Fig. 1. RC Airplane top view. The result of almost 60 hours of work. First Radio Control (RC) plane I ever built.

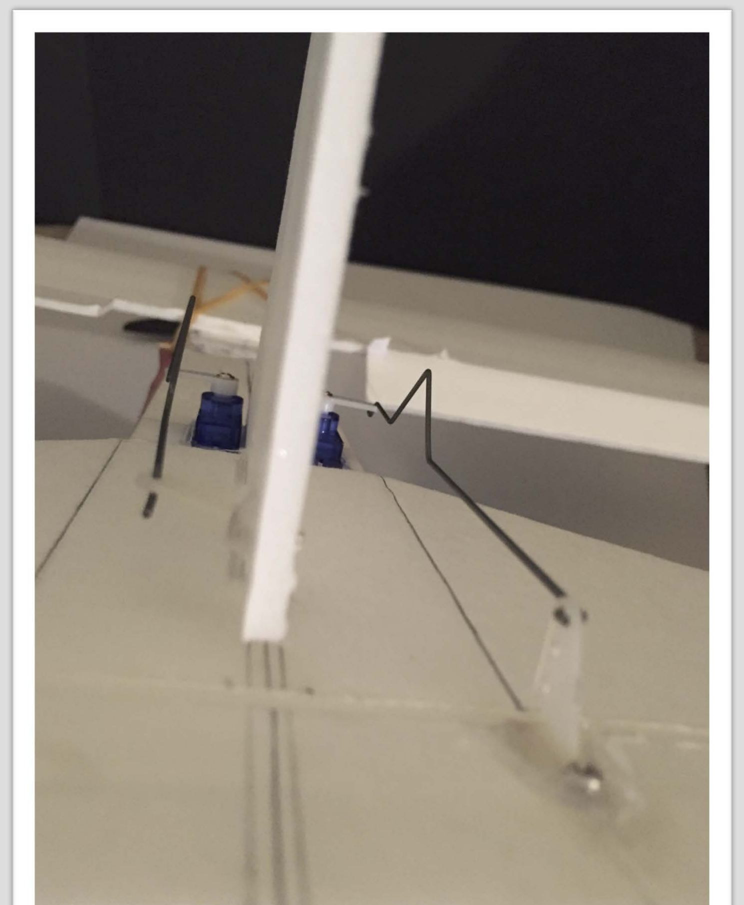
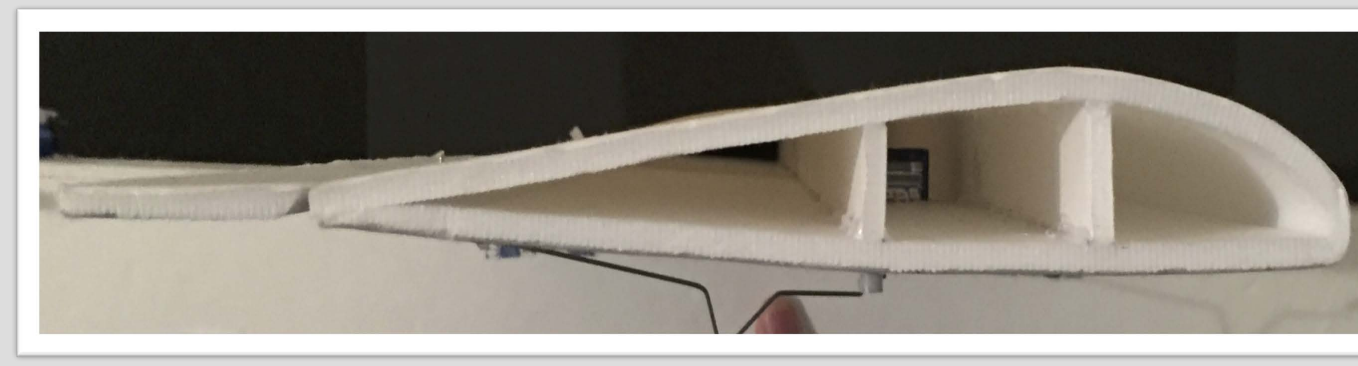


Fig. 2. Airplane tail view. Closeup of rudder and elevator servos, pushrods, and control horns.

Fig. 3. Access Hatch, battery, and Electronic Speed Control (ESC) close up.



RESULTS

DATA

- (1) Crashed RC airplane
- **Maximum Altitude**: 40.5 feet above sea level
- **Maximum Speed:** 15.6 MPH
- **Total Flight Time:** 3.09s
- **Distance Traveled**: 45.3 feet

Fig. 5. Rudder and Elevator closeup

SUMMARY / CONCLUSIONS

Summary:

I had a great deal of fun designing and building my own RC plane. Additionally, learning the mathematical and physics concepts behind fixed-wing aircraft flight was a fulfilling intellectual experience. In fact, on multiple occasions Dad had to come into my room at 2AM to tell me to stop working and go to bed. Overall, I was satisfied with how the plane came out, given that I had never built a RC plane before. Unfortunately, during the maiden flight, a sudden gust of wind struck the plane 2 seconds into flight, I panicked, and the plane nosedived into the ground, ruining the motor.

Conclusions:

Because the plane crashed 3.054 seconds into its very first flight and could not be repaired in the limited time I had, no meaningful conclusions (other than "definitely do not fly a RC plane with unknown flight characteristics in 20 mph winds") can be drawn from this research.

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References

Shevell, Richard Shepherd. *Fundamentals of Flight*. 2nd ed. Englewood Cliffs, NJ: Prentice Hall, 1989. Print.