SMALL-SCALE PROPELLER PERFORMANCE AT LOW SPEEDS

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THESIS

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Abstract

Very little research has been performed that investigates the performance characteristics of small-scale propellers. As a result, design and prediction capabilities for such propellers are currently incomplete. In order to address this, an experiment was developed to acquire performance data for small-scale propellers in the UIUC low speed wind tunnel. This thesis documents the design and implementation of these tests, presents the performance data for 79 different propellers, and offers some preliminary analysis of the data. It is shown that the tests produce high-fidelity data. The preliminary analysis shows that there are a myriad of interesting trends that warrant further study.

Appendix A

Tabulated Geometry

In this appendix, the geometry of the propellers tested is provided in tabular form. Table A.1 provides the thickness ratios of the hub and tip used in the digitization process, the true diameter of each propeller, and the chord length at the three-quarter radial position for all propellers tested. The thickness ratios used are not necessarily the true airfoil thickness ratios, but the thickness ratios that are used by *PropellerScanner* to correct for the optical effects of the airfoil thickness (see Ref. [31]). These were estimated simply by analyzing the propeller and estimating the apparent thickness. For every propeller tested, the normalized chord and pitch distributions are given at 18 linearly spaced radial locations ranging from the 15% radial position to the tip.

Table A.1: Summary of Propeller Geometry

Brand	Style	Designation	$(t/c)_{hub}$	$(t/c)_{tip}$	D_{true} (in)	$c_{0.75R}$ (in)
APC	Slow Flyer	9×4.7	0.06	0.06	8.90	0.886
		9×6	0.06	0.06	9.00	0.905
		10×4.7	0.06	0.06	10.00	0.985
		10×7	0.06	0.06	10.05	0.990
		11×3.8	0.06	0.06	11.00	1.111
		11×4.7	0.06	0.06	11.00	1.095
		11×7	0.06	0.06	11.00	1.111
APC	Sport	9×5	0.12	0.08	9.00	0.657
		9×7	0.12	0.08	9.00	0.662
		10×6	0.12	0.08	10.00	0.770
		10×8	0.12	0.08	10.00	0.775
		11×4	0.12	0.08	11.00	0.787
		11×5	0.12	0.08	11.00	0.781
		11×6	0.12	0.08	11.00	0.792
		11×7	0.12	0.08	11.00	0.787
		11×8	0.12	0.08	11.00	0.787
		11×9	0.12	0.08	11.00	0.792
APC	120 Pattern	14×13	0.12	0.08	14.00	1.008
APC	Thin Electric	9×4.5	0.12	0.06	9.00	0.675
		9×6	0.12	0.06	9.00	0.675
		10×5	0.12	0.06	10.00	0.640
		10×7	0.12	0.06	10.00	0.645
		11×5.5	0.12	0.06	11.00	0.666

Table A.1: Summary of Propellers Geometry (*continued*)

Brand	Style	Designation	$(t/c)_{hub}$	$(t/c)_{tip}$	D_{true} (in)	$c_{0.75R}$ (in)
		11×7	0.12	0.06	11.00	0.688
		11×8	0.12	0.06	11.00	0.677
		11×8.5	0.12	0.06	11.00	0.677
		11×10	0.12	0.06	11.00	0.688
		14×12	0.12	0.06	14.00	0.721
		17×12	0.12	0.06	17.00	0.884
		19×12	0.12	0.06	19.00	0.969
Graupner	CAM Prop	9×4	0.12	0.06	9.10	0.551
		9×6	0.12	0.06	9.20	0.616
		10×6	0.12	0.06	10.00	0.650
		10×8	0.12	0.06	10.00	0.675
		11×4	0.12	0.06	11.15	0.680
		11×6	0.12	0.06	11.20	0.666
		11×8	0.12	0.06	11.20	0.717
Graupner	CAM Slim	9×6	0.06	0.06	9.15	0.769
		10×6	0.06	0.06	9.90	0.747
		10×8	0.06	0.06	9.90	0.752
Graupner	Slim	9×5	0.06	0.06	9.15	0.737
Graupner	Super Nylon	9×5	0.08	0.08	9.05	0.796
		9×7	0.08	0.08	9.05	0.787
		10×6	0.08	0.08	9.85	0.832
		10×7	0.08	0.08	9.85	0.822
		11×6	0.08	0.08	11.05	0.928

Table A.1: Summary of Propellers Geometry (*continued*)

Brand	Style	Designation	$(t/c)_{hub}$	$(t/c)_{tip}$	D_{true} (in)	$c_{0.75R}$ (in)
		11×8	0.08	0.08	11.10	0.944
GWS	Direct Drive	9×5	0.06	0.06	9.00	0.675
		10×6	0.06	0.06	10.00	0.695
		11×7	0.06	0.06	11.00	0.820
GWS	Slow Flyer	9×4.7	0.06	0.06	9.05	0.891
		9×7	0.06	0.06	9.00	0.895
		10×4.7	0.06	0.06	10.10	1.040
		10×8	0.06	0.06	10.05	1.005
		11×4.7	0.06	0.06	11.00	1.122
		11×8	0.06	0.06	11.00	1.084
Kyosho		9×6	0.12	0.08	9.00	0.599
		10×6	0.12	0.08	10.00	0.675
		10×7	0.12	0.08	10.00	0.680
		11×7	0.12	0.08	11.00	0.737
		11×9	0.12	0.08	11.00	0.732
Master Airscrew	Electric	9×6	0.08	0.08	9.10	0.692
		10×7	0.08	0.08	10.10	0.727
		11×7	0.08	0.08	11.10	0.816
Master Airscrew	G/F	9×4	0.12	0.06	9.00	0.644
		9×6	0.12	0.06	9.00	0.635
		10×6	0.12	0.06	10.10	0.777
		10×8	0.12	0.06	10.10	0.788
		11×4	0.12	0.06	11.00	0.781

Table A.1: Summary of Propellers Geometry (*continued*)

Brand	Style	Designation	$(t/c)_{hub}$	$(t/c)_{tip}$	D_{true} (in)	$c_{0.75R}$ (in)
		11×6	0.12	0.06	11.00	0.781
		11×7	0.12	0.06	11.00	0.770
		11×8	0.12	0.06	11.00	0.787
Master Airscrew	Scimitar	9×5	0.12	0.06	9.10	0.605
		9×7	0.12	0.06	9.10	0.642
		10×5	0.12	0.06	10.00	0.675
		10×7	0.12	0.06	10.00	0.665
		11×6	0.12	0.06	11.05	0.691
		11×7	0.12	0.06	10.95	0.712
		11×8	0.12	0.06	11.10	0.733