

1/48

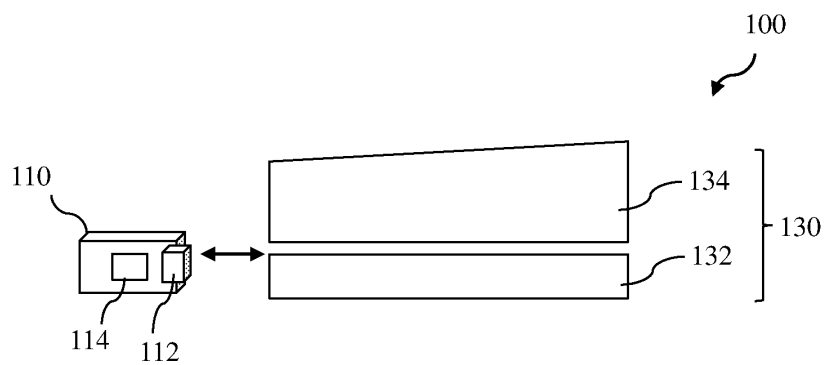


FIG. 1

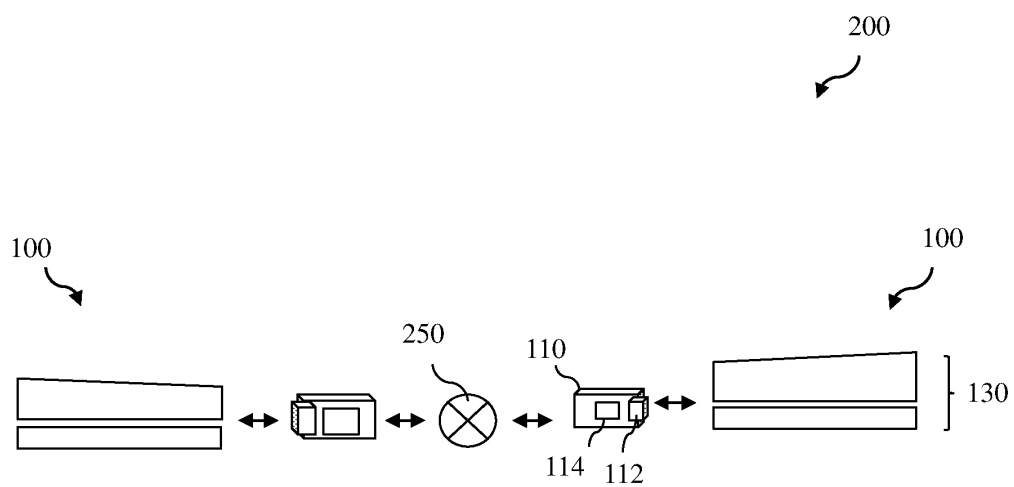


FIG. 2

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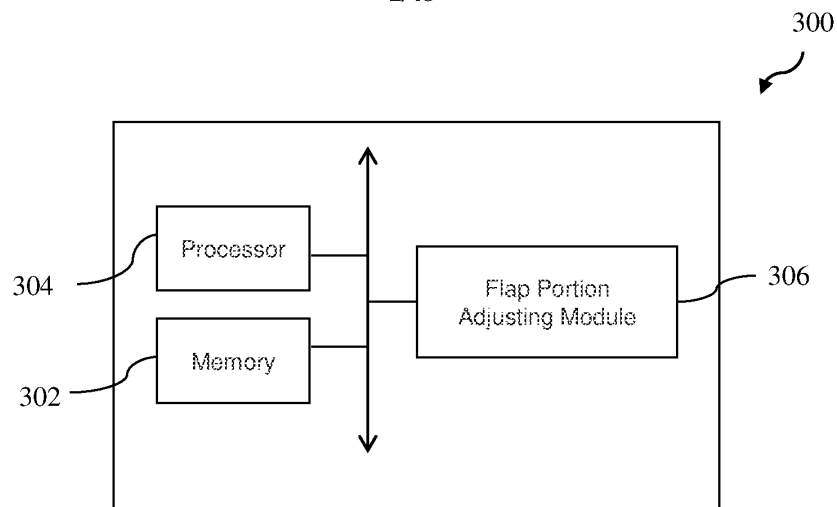


FIG. 3

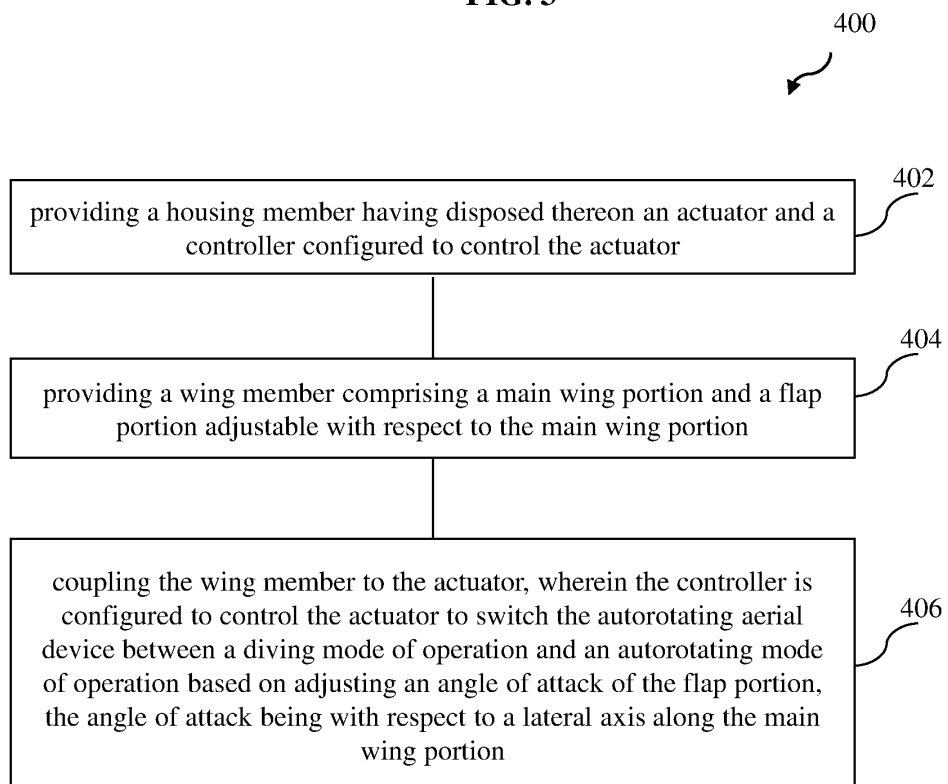


FIG. 4

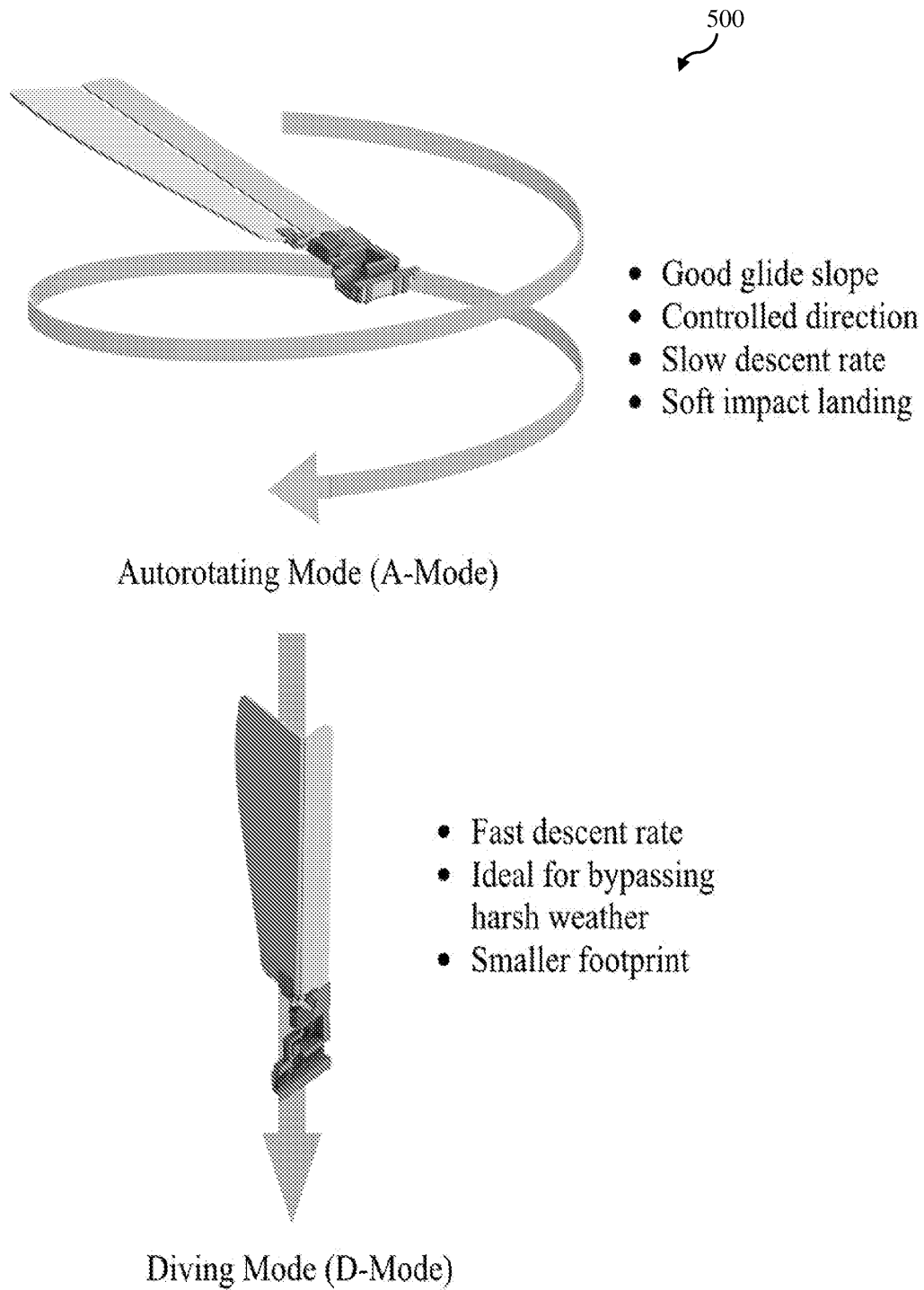


FIG. 5A

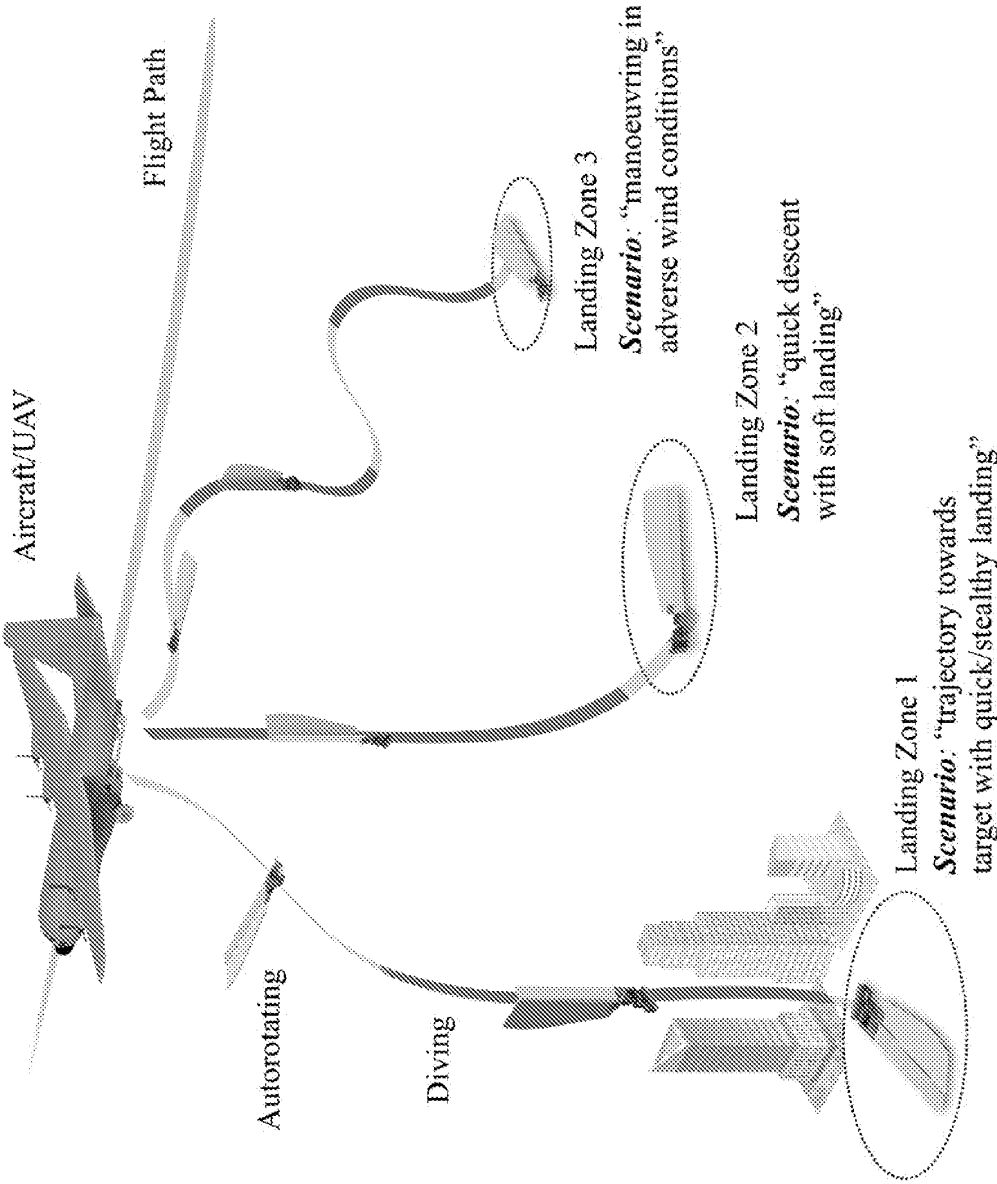


FIG. 5B

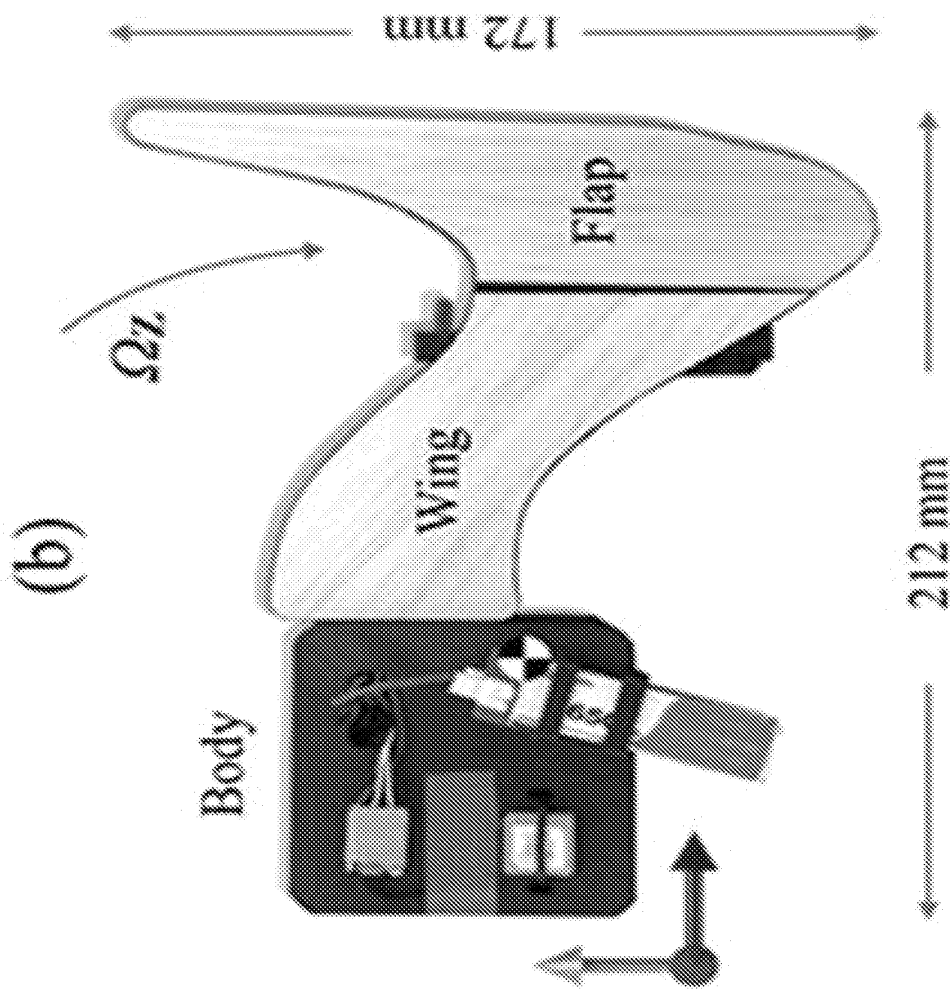


FIG. 5C

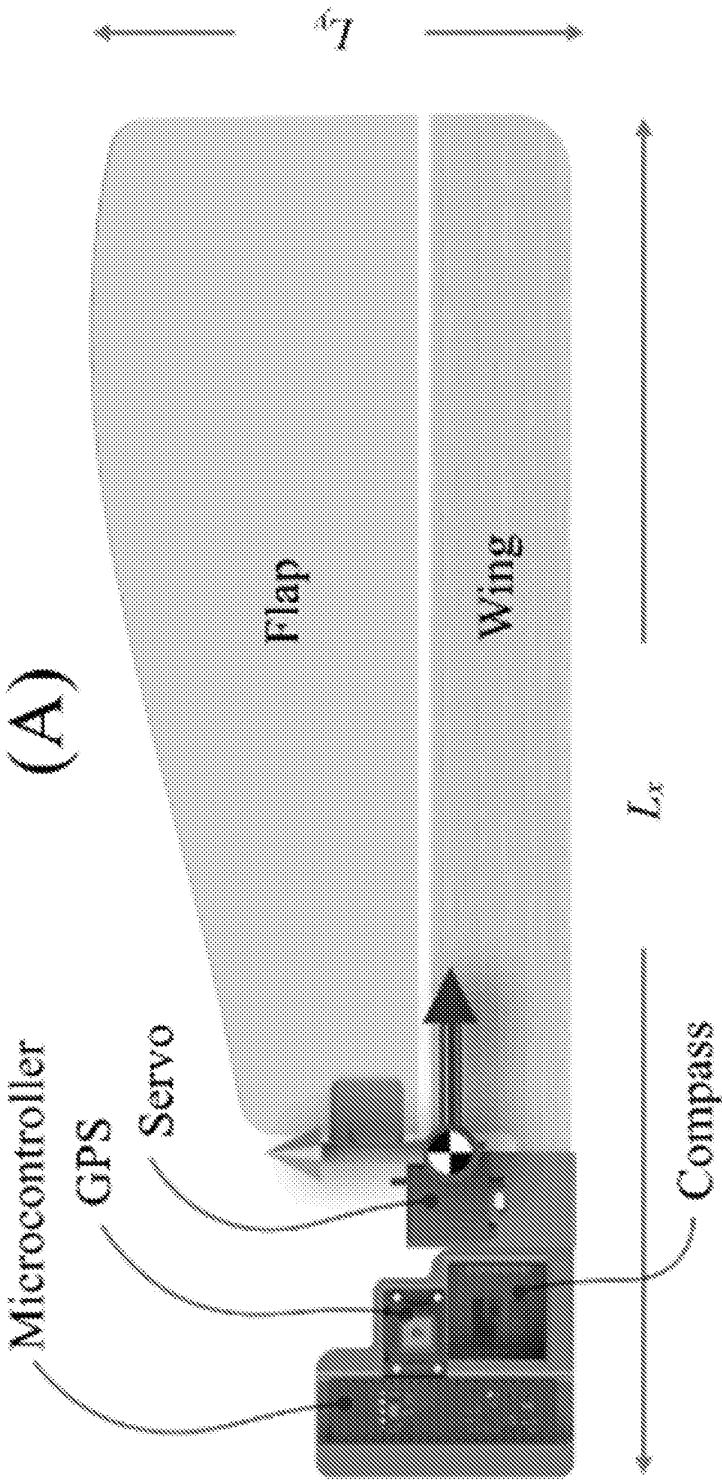


FIG. 6A

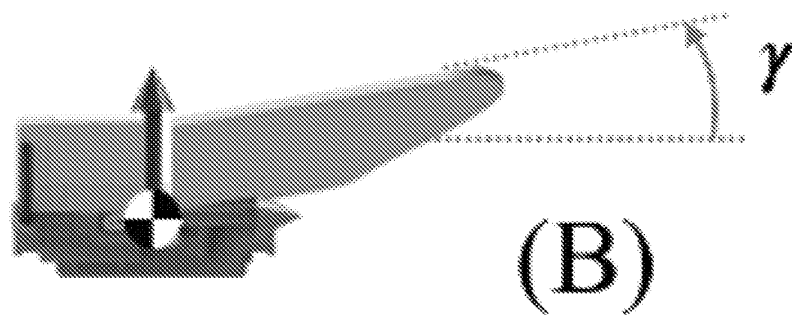


FIG. 6B

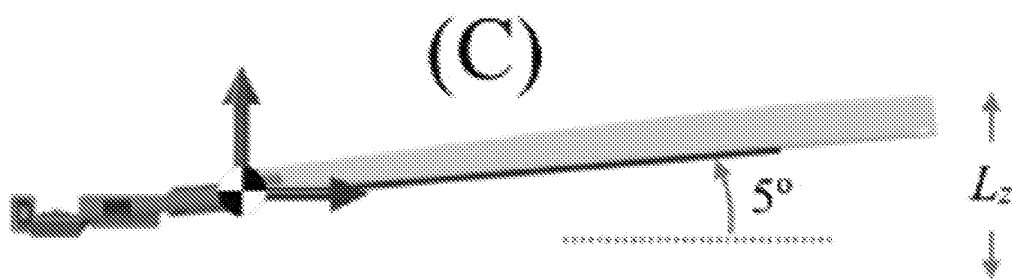


FIG. 6C

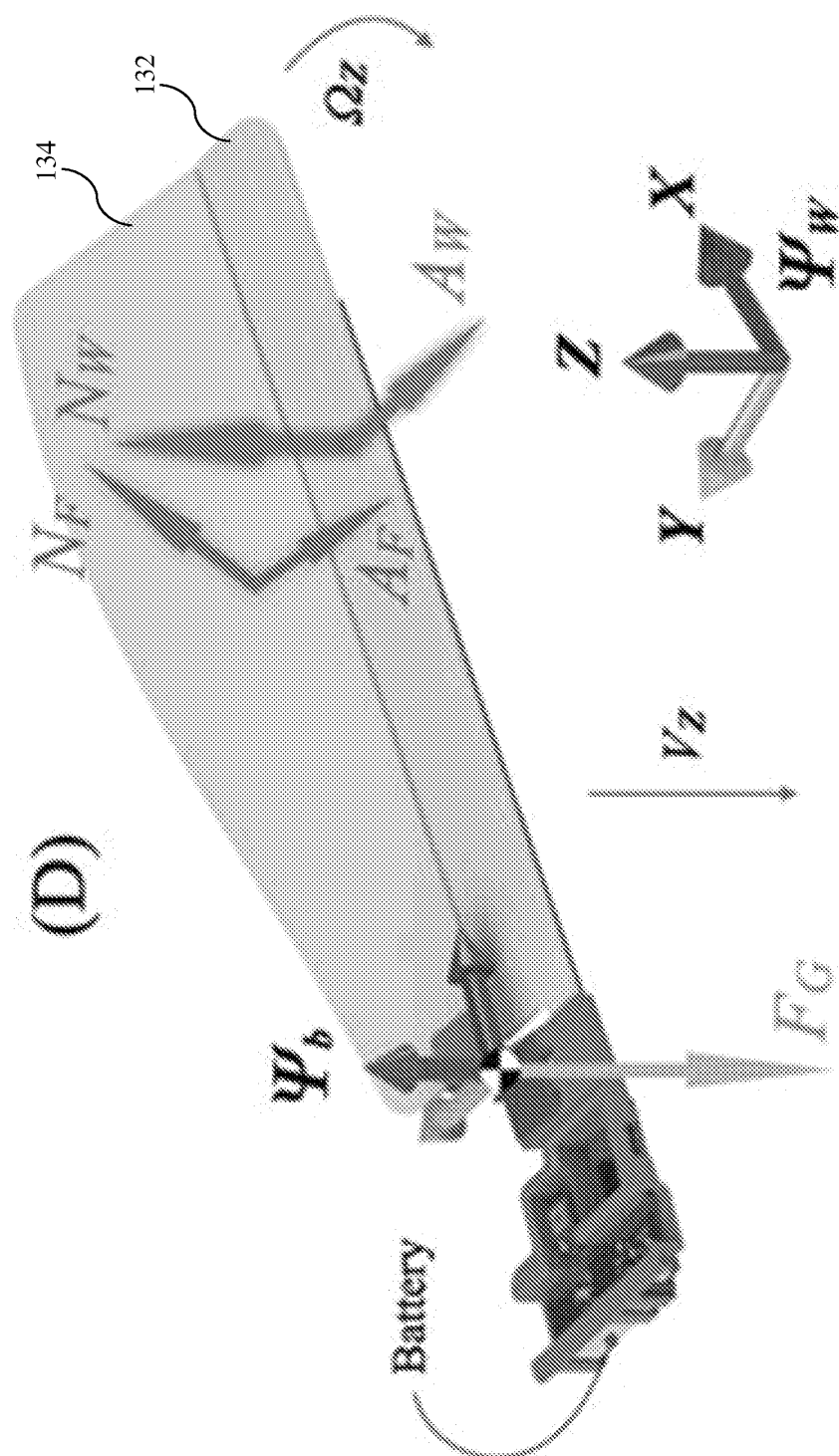


FIG. 6D

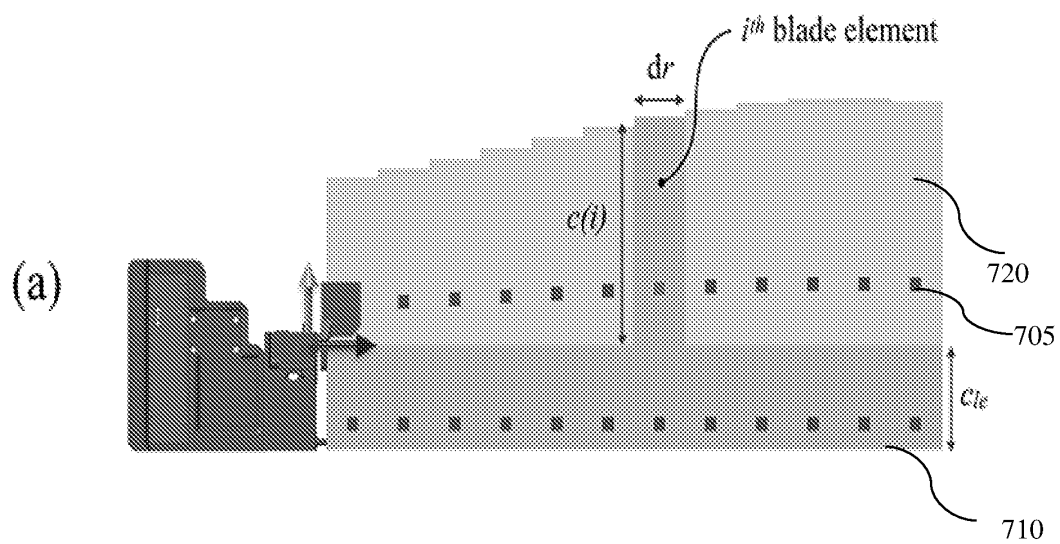


FIG. 7A

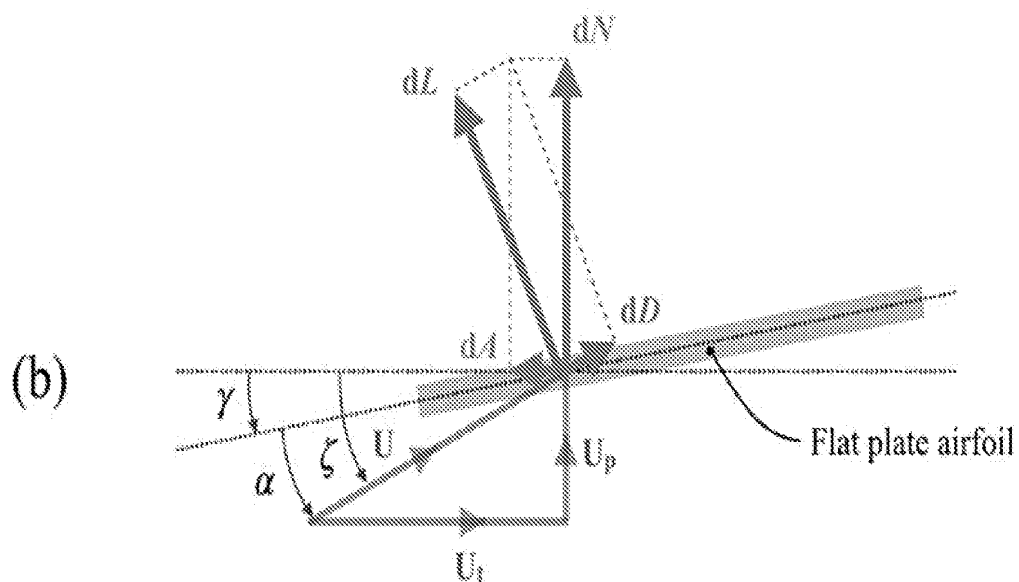


FIG. 7B

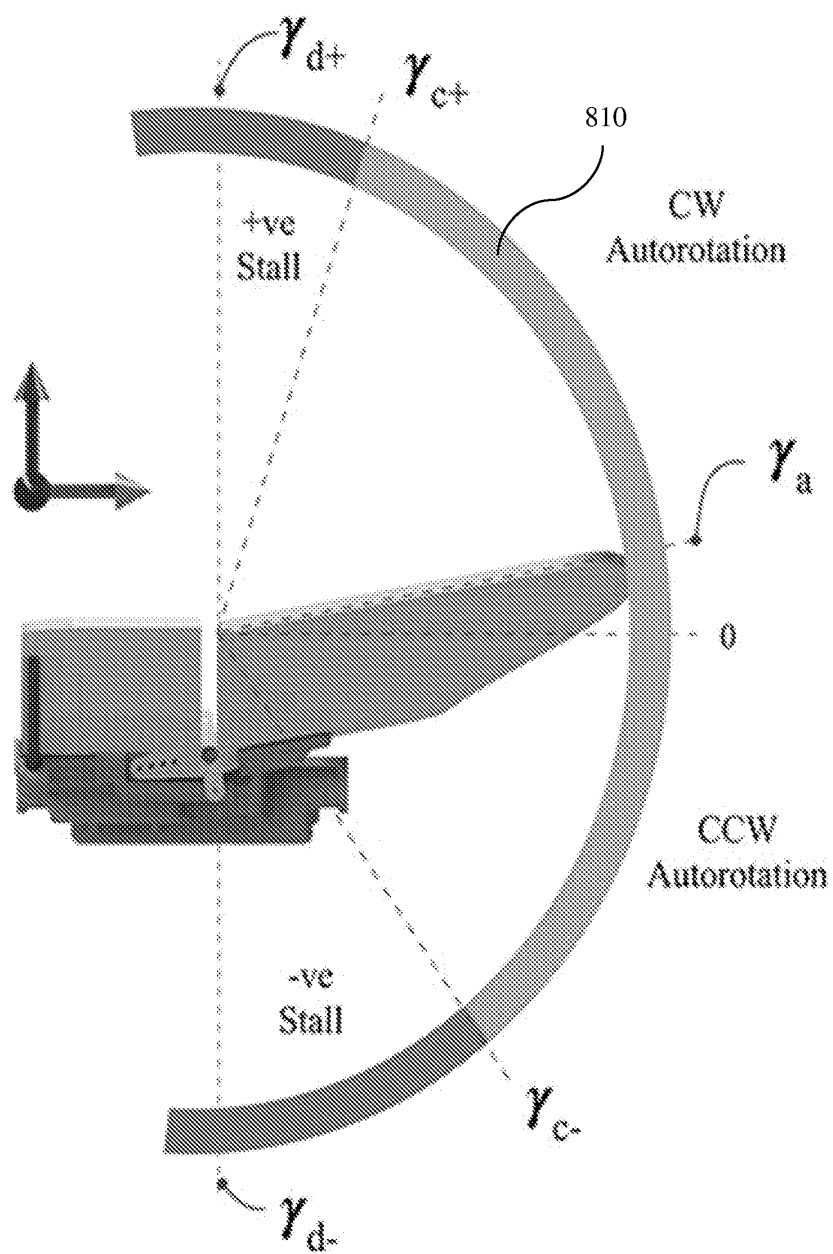


FIG. 8

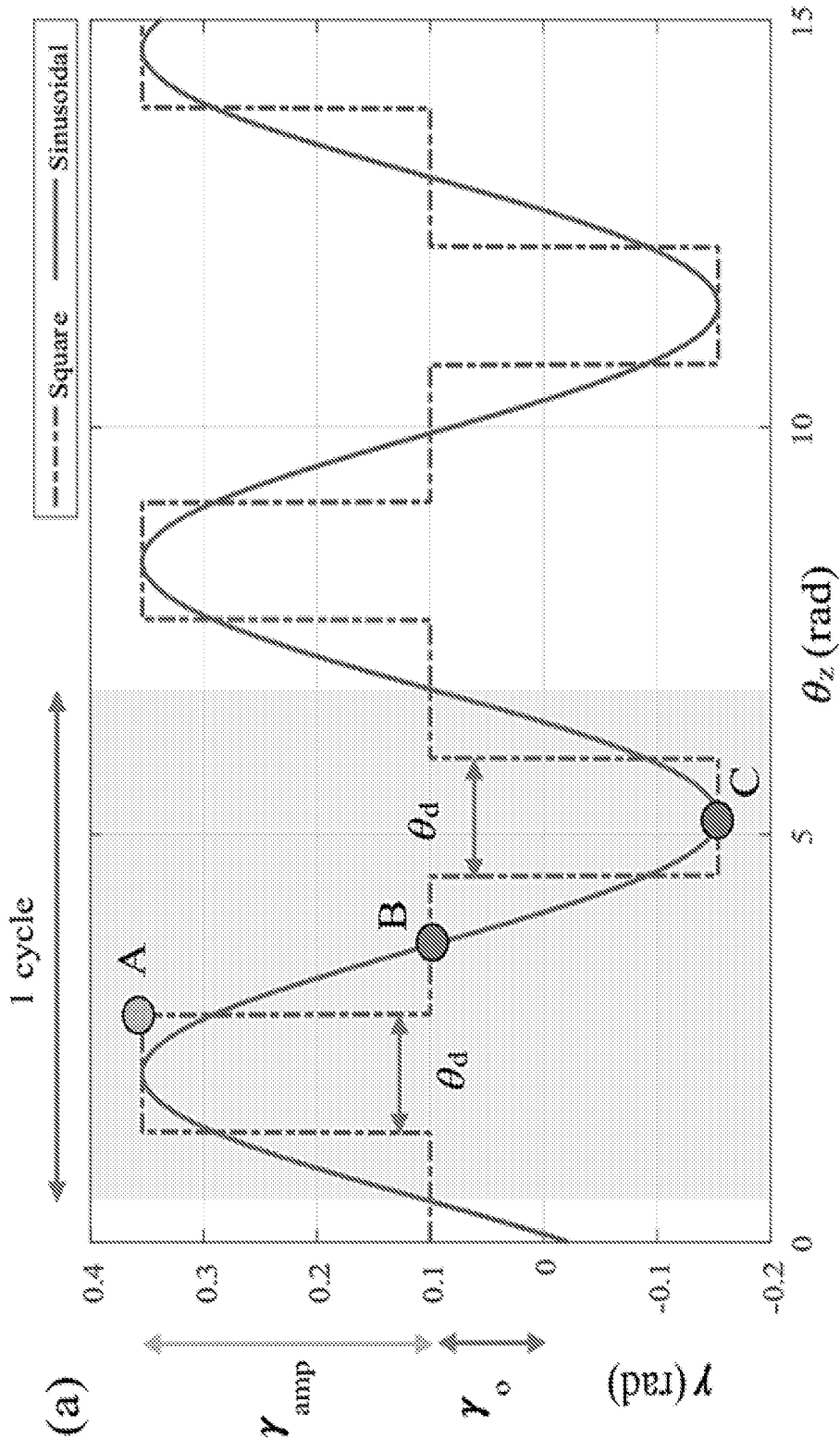


FIG. 9A

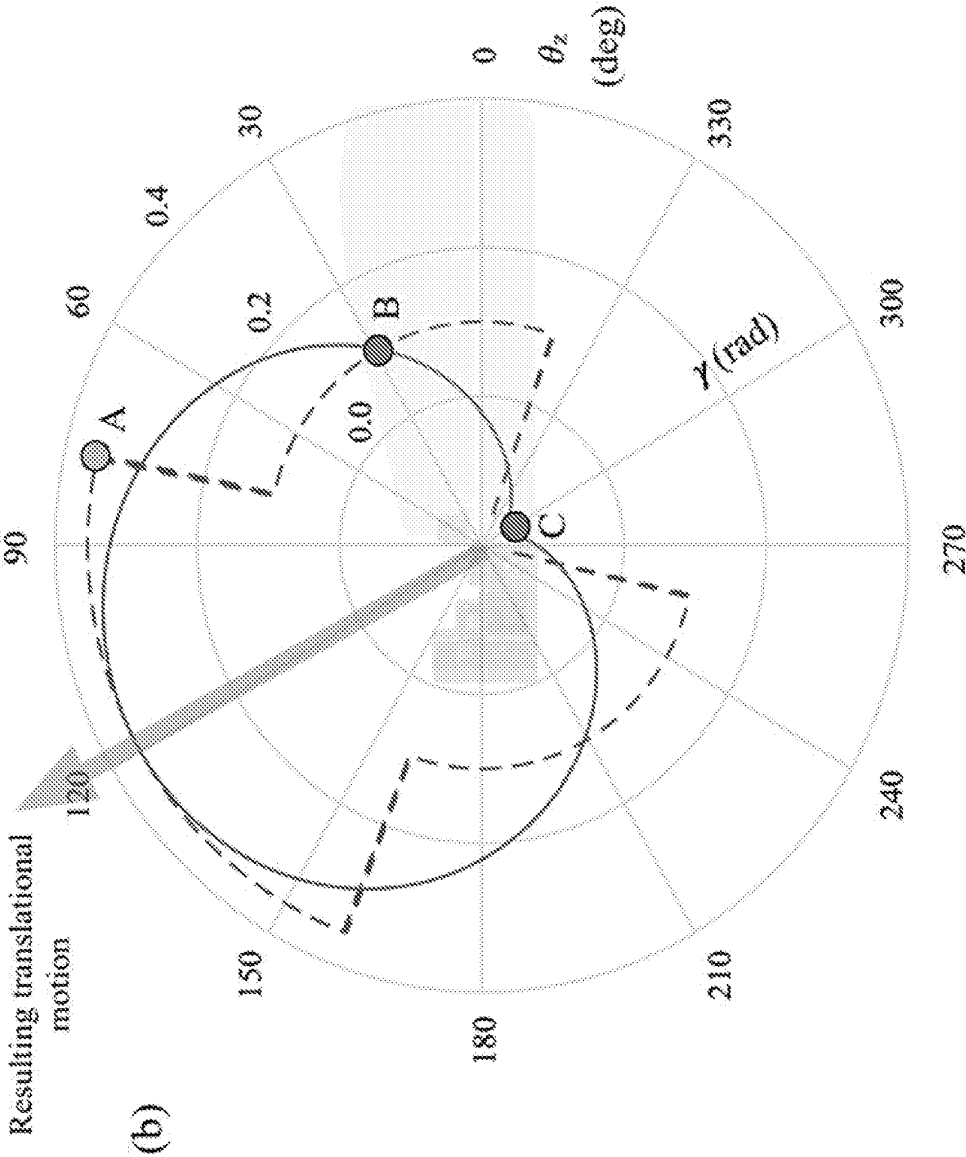


FIG. 9B

Table 3
TABLE OF SIMULATION PARAMETERS

PARAMETERS	
Environment	$\rho_{air} = 1.225\text{kg/m}^3, g = -9.81\text{m/s}$
Initial conditions	$V_Z = 0\text{m/s}, \Omega_Z = -18.8\text{rad/s}$
Objective fn coeffs	$\kappa_1 = 100, \kappa_2 = 500, \kappa_3 = 200, \kappa_4 = 1$ $\beta_1 = 1, \beta_2 = 10, \beta_3 = 400$
Others	$n_1 = 3000, n_2 = 40000, t_s = 0\text{s}, t_f = 40\text{s}$ $n_3 = 10000, n_4 = 40000, t_{s2} = 10\text{s}, t_{f2} = 40\text{s}$ $n_{be} = 12, c_{min} = 30\text{mm}, c_{max} = 120\text{mm}$
OPTIMIZED DESIGN VARIABLES	
Polynomial coeffs	$C_1 = -0.0325, C_2 = 0.4175, C_3 = 2.1997,$ $C_4 = 58.5336$
Chord lengths (mm)	$c_1 = 61.1, c_2 = 64.3, c_3 = 68.0, c_4 = 71.9$ $c_5 = 75.9, c_6 = 79.7, c_7 = 83.2, c_8 = 86.2$ $c_9 = 88.5, c_{10} = 89.8, c_{11} = 90.0, c_{12} = 88.9$
Radius (mm)	$dr = 23, R = 276$
Others	$\gamma_a = 0.1887\text{rad}, m = 58\text{g}$ $L_x = 368\text{mm}, L_y = 131\text{mm}, L_z = 44\text{mm}$
OPTIMIZED CONTROL VARIABLES	
Control vars	$\gamma_o = -0.1345, \epsilon = 0.2010, \gamma_{amp} = 0.1188$
Others	$\lambda_c = 0$

FIG. 10

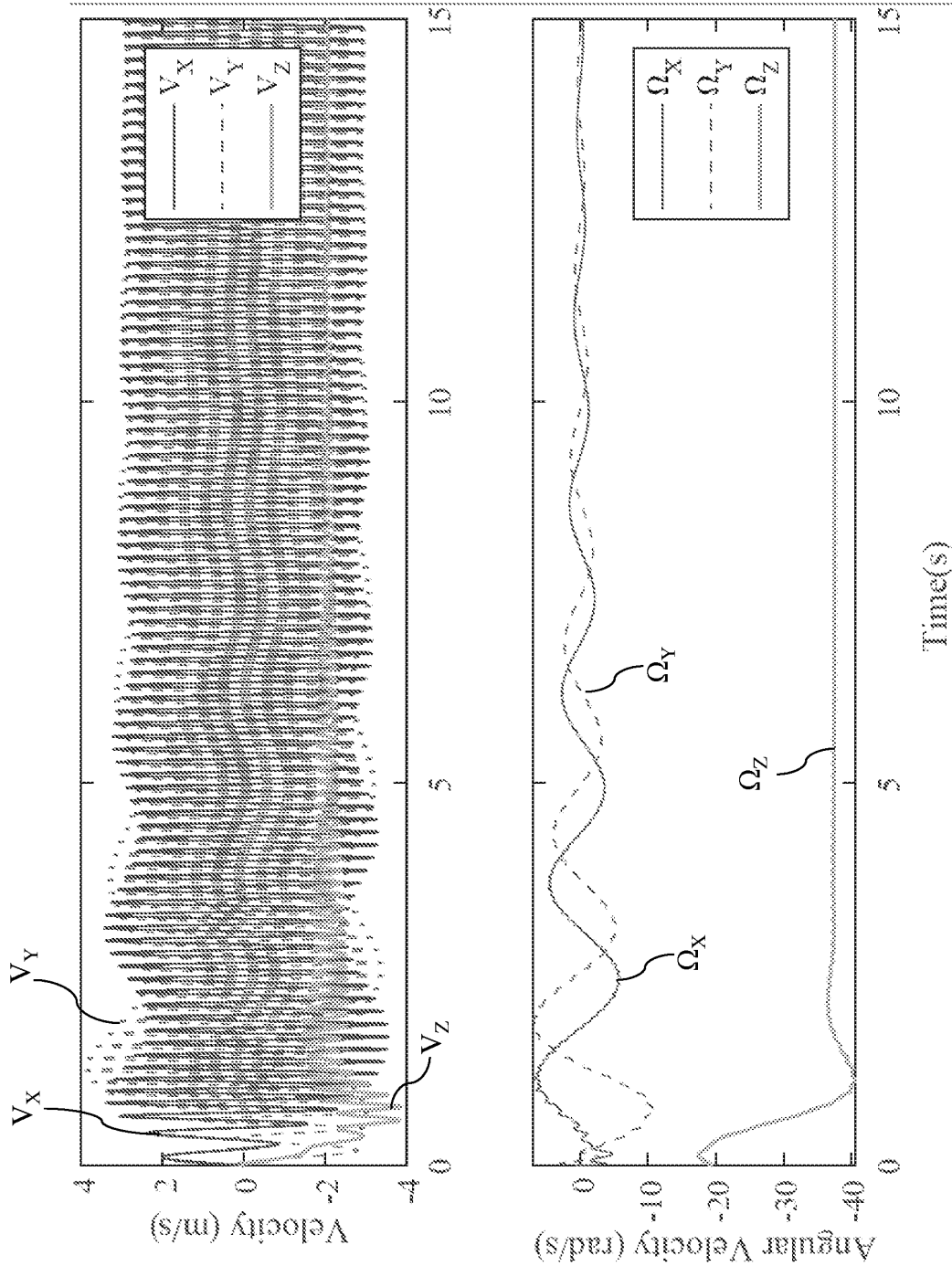


FIG. 11

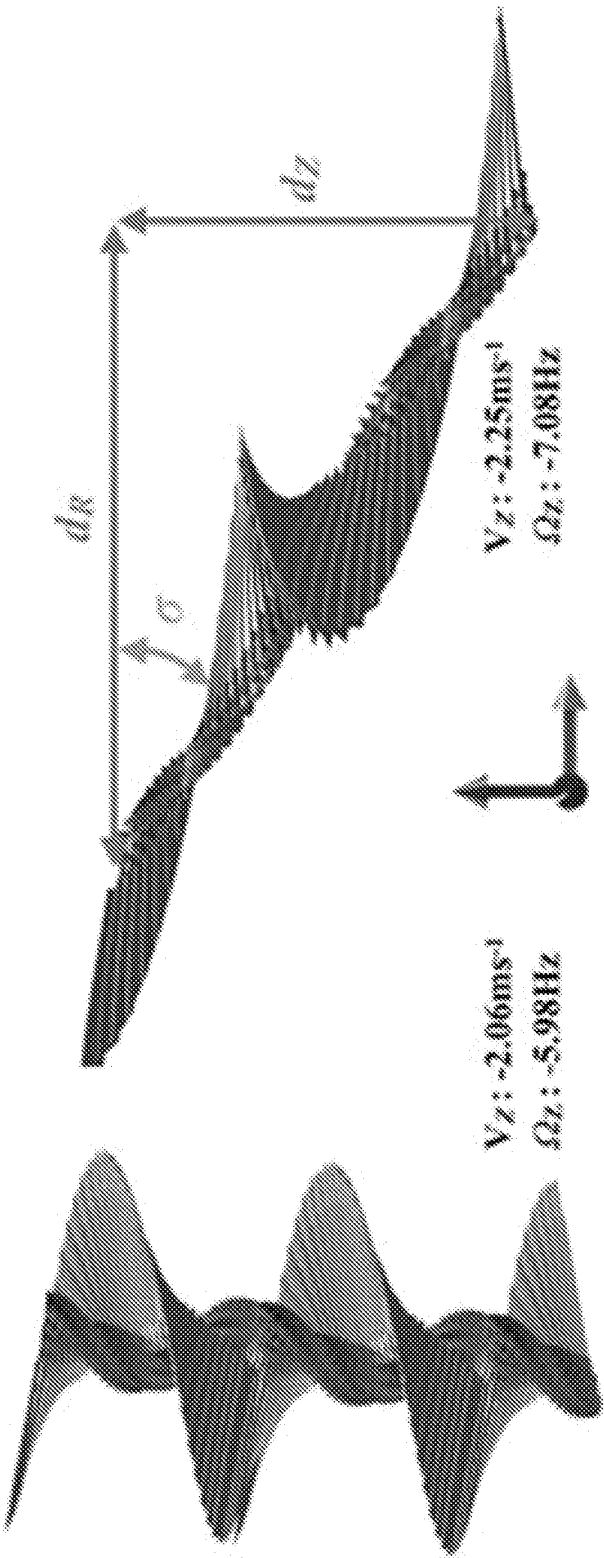


FIG. 12

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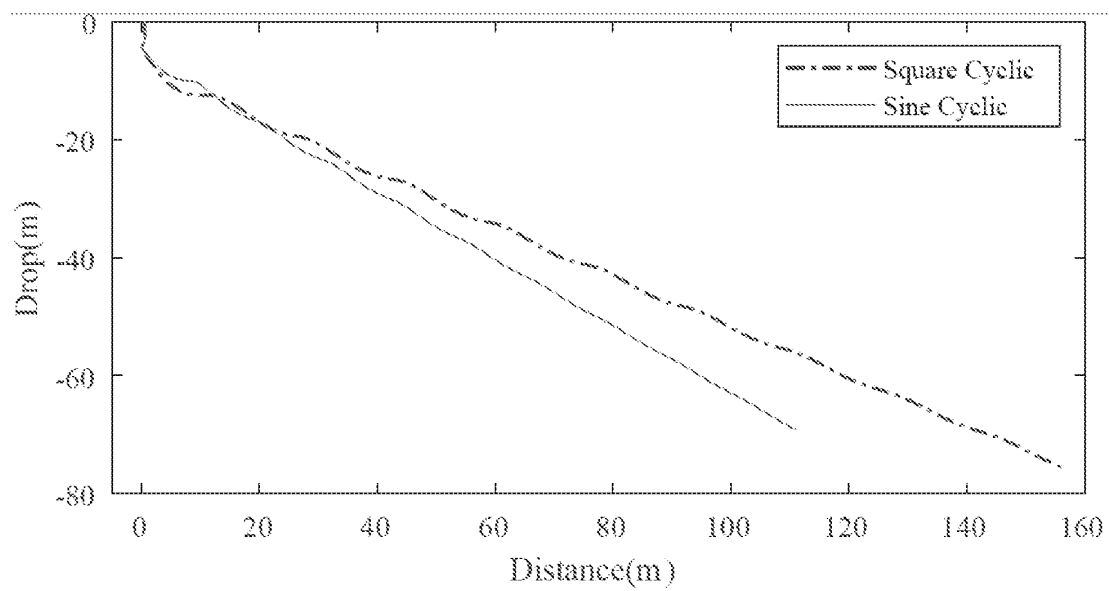


FIG. 13A

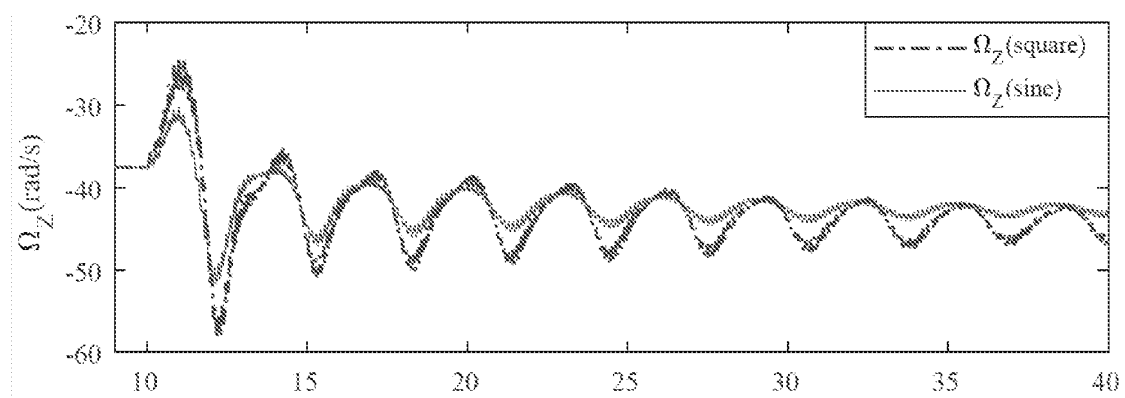


FIG. 13B

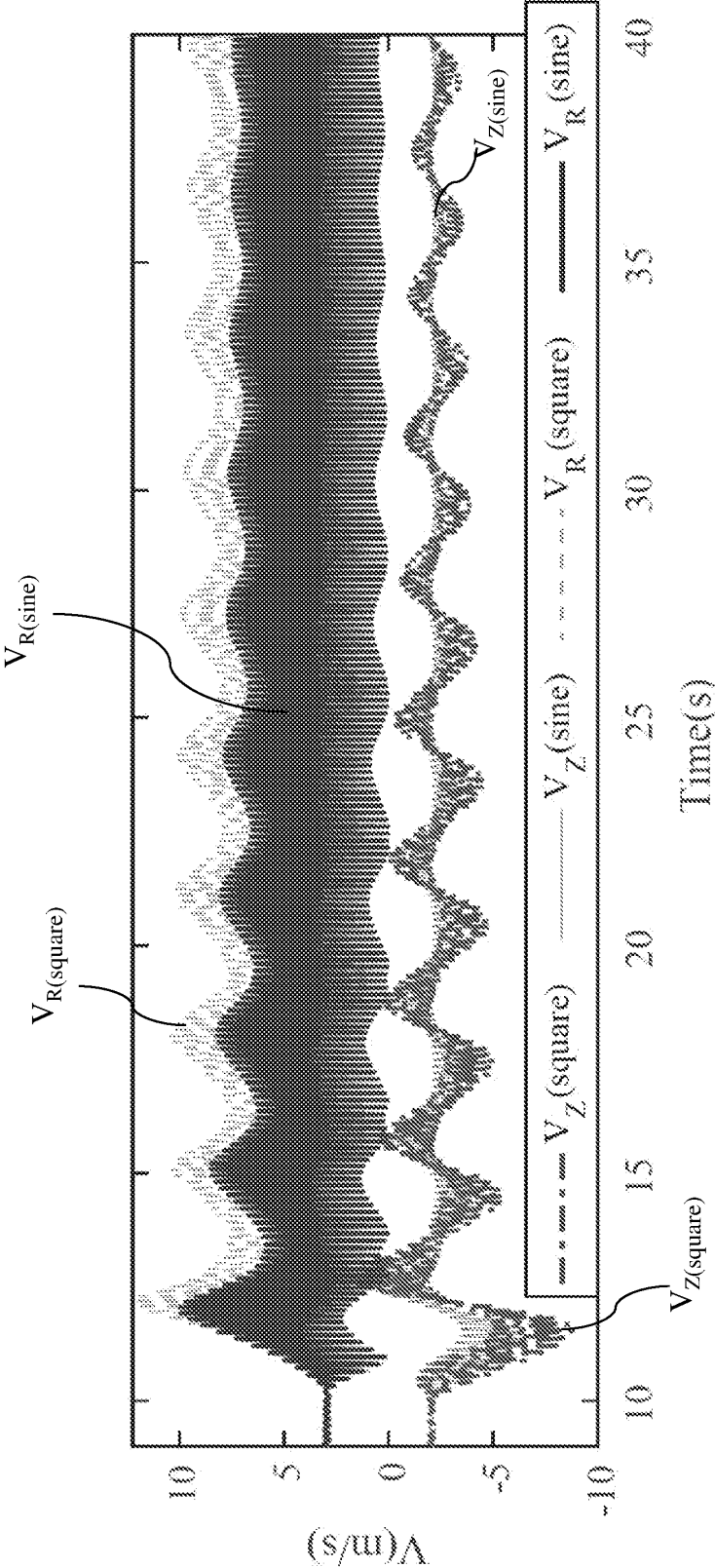


FIG. 13C

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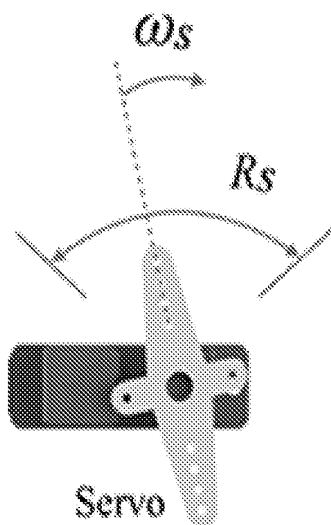


FIG. 14A

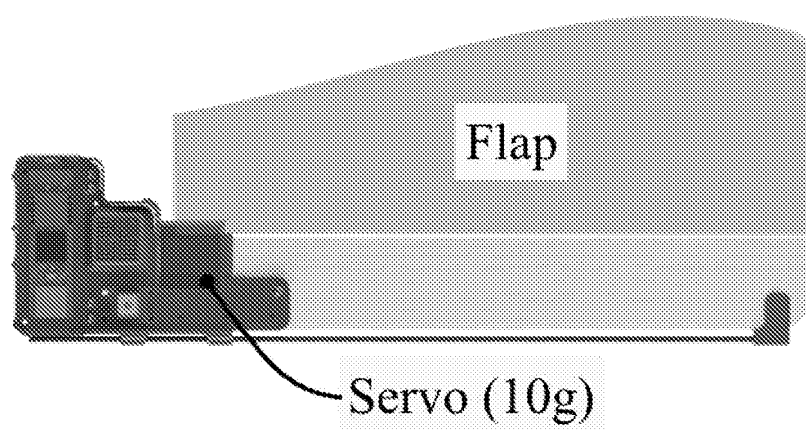


FIG. 14B

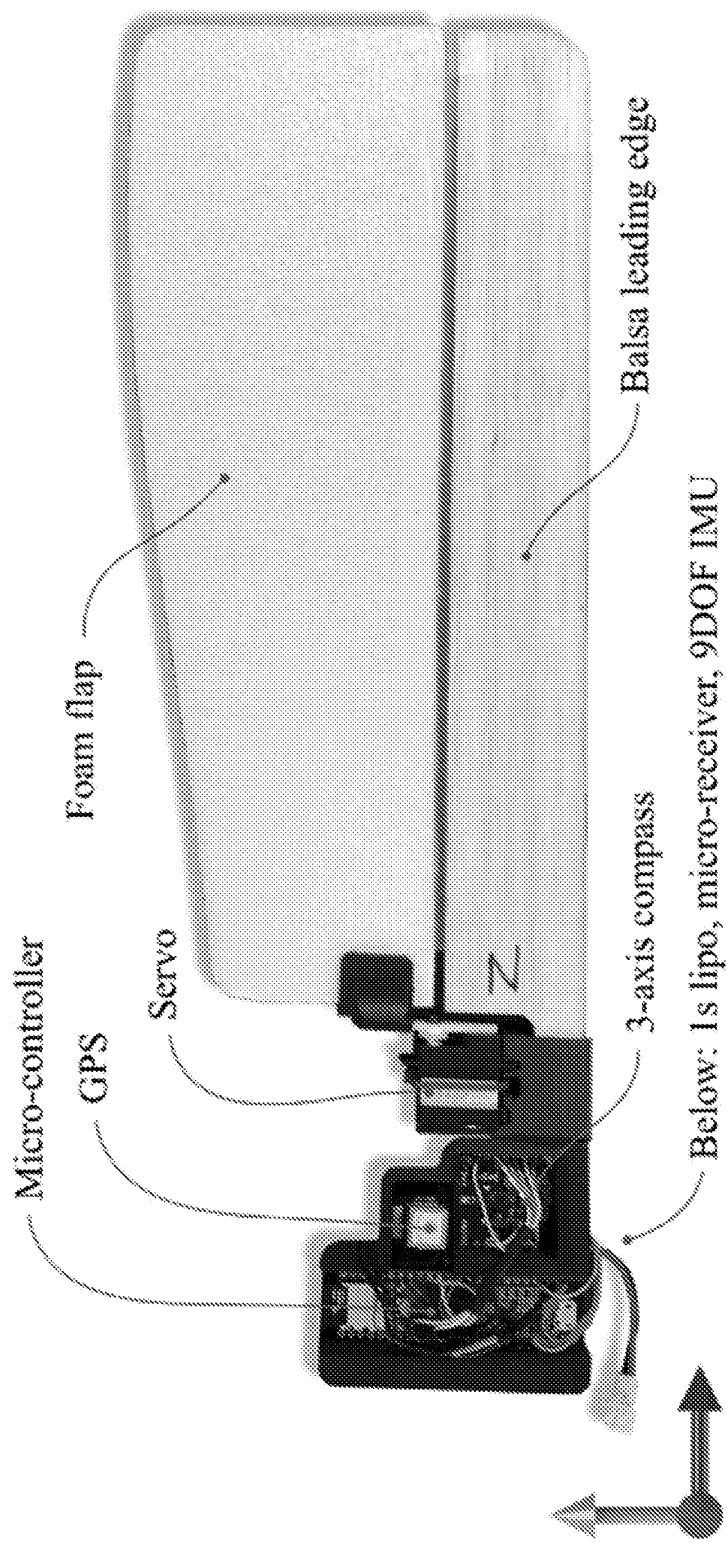


FIG. 14C

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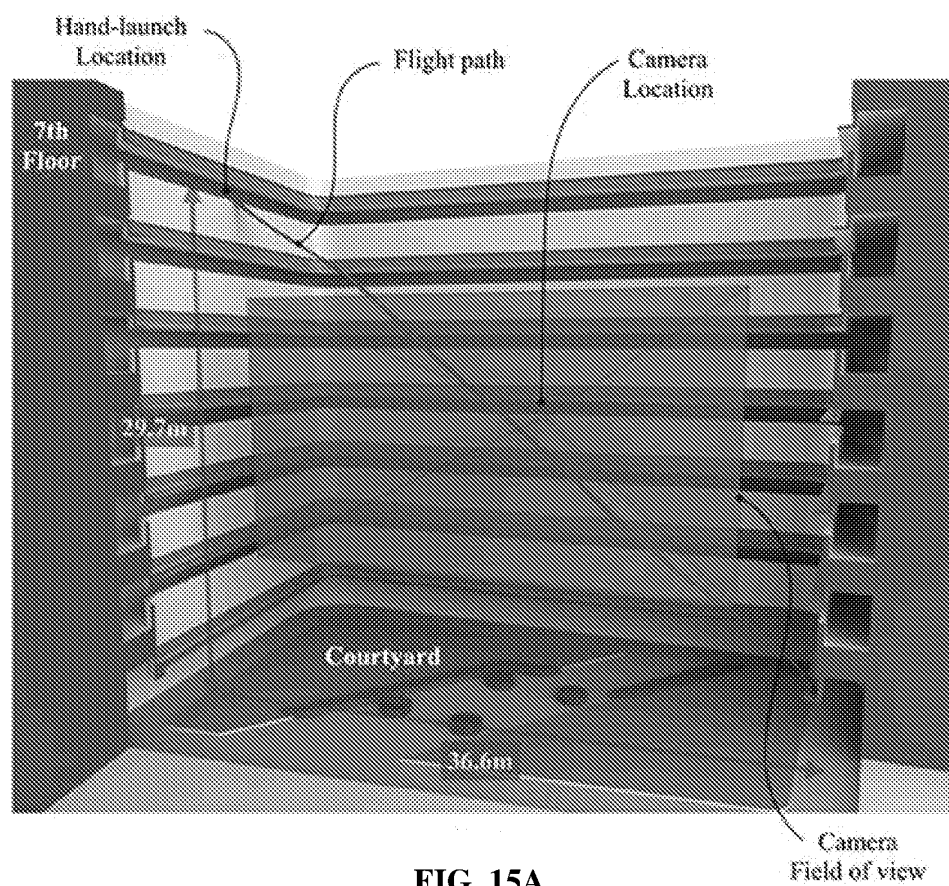


FIG. 15A

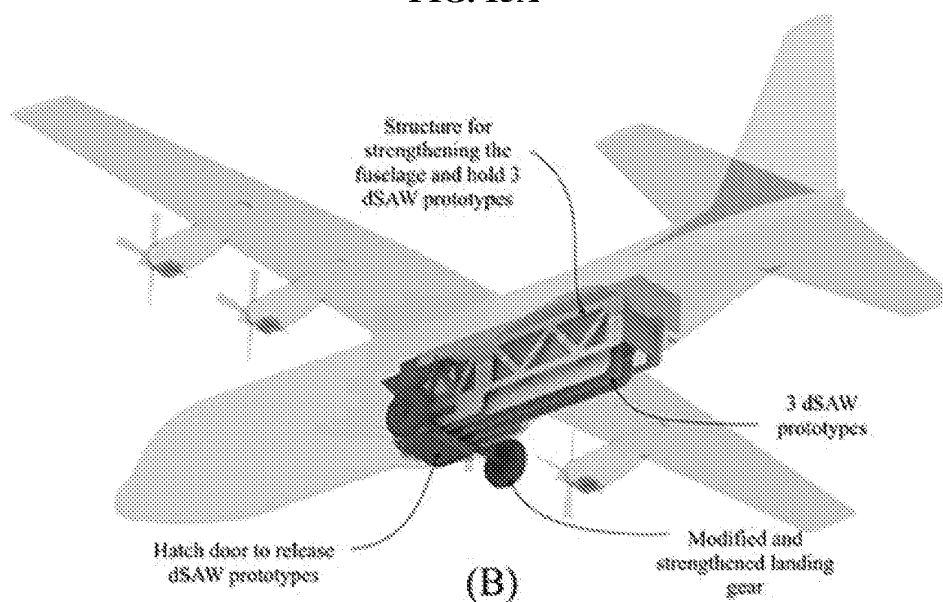


FIG. 15B

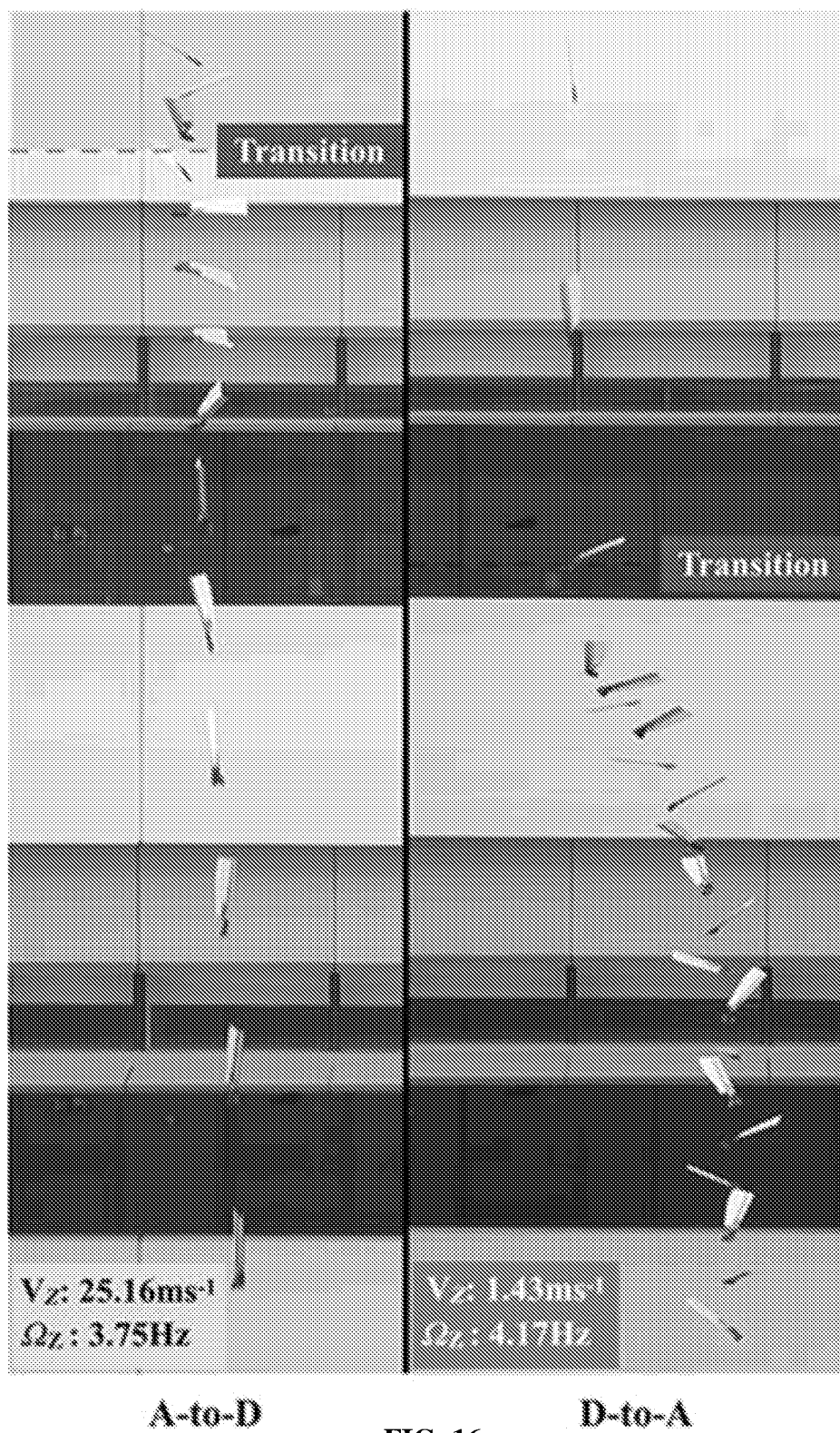


FIG. 16

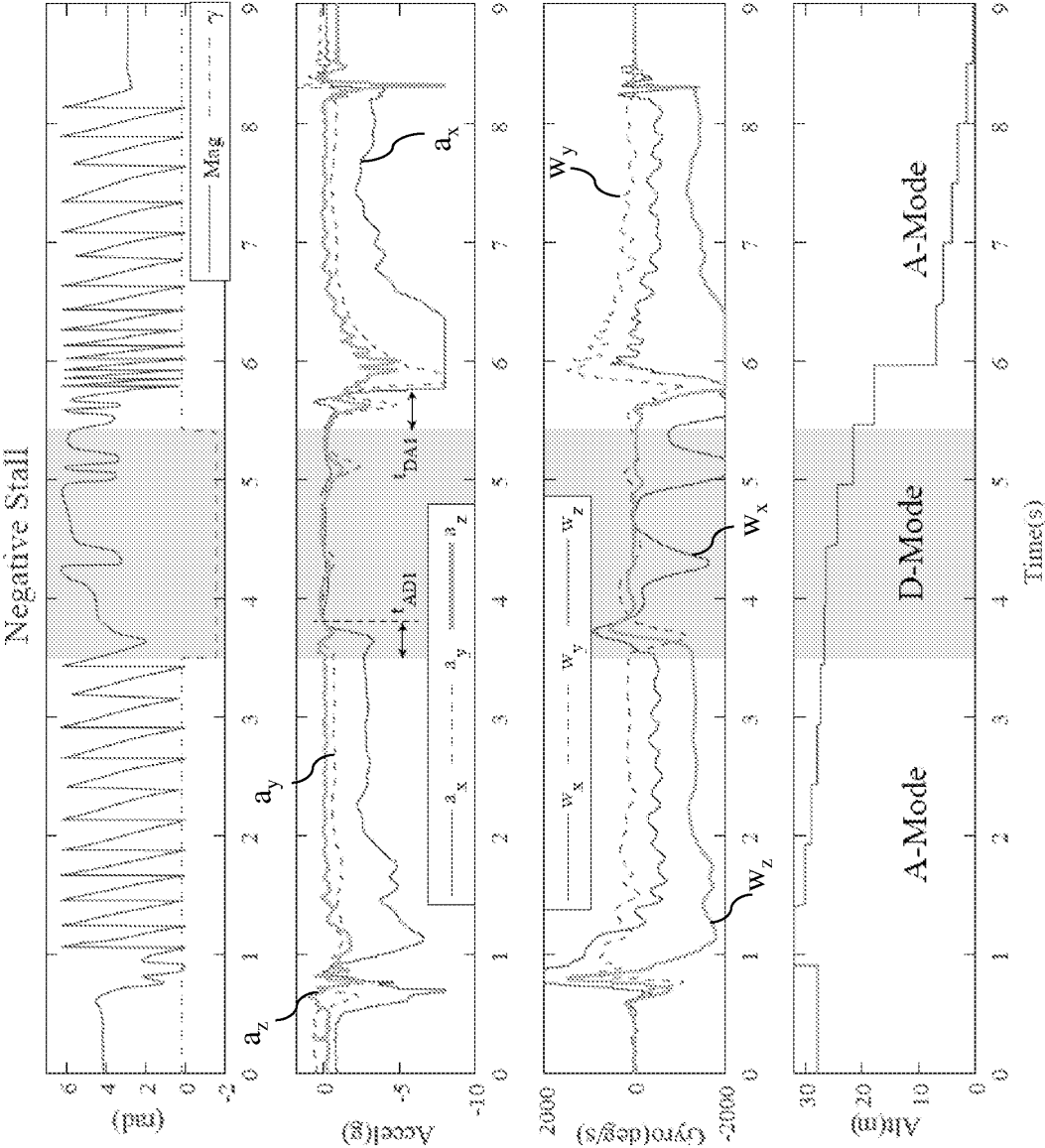


FIG. 17A

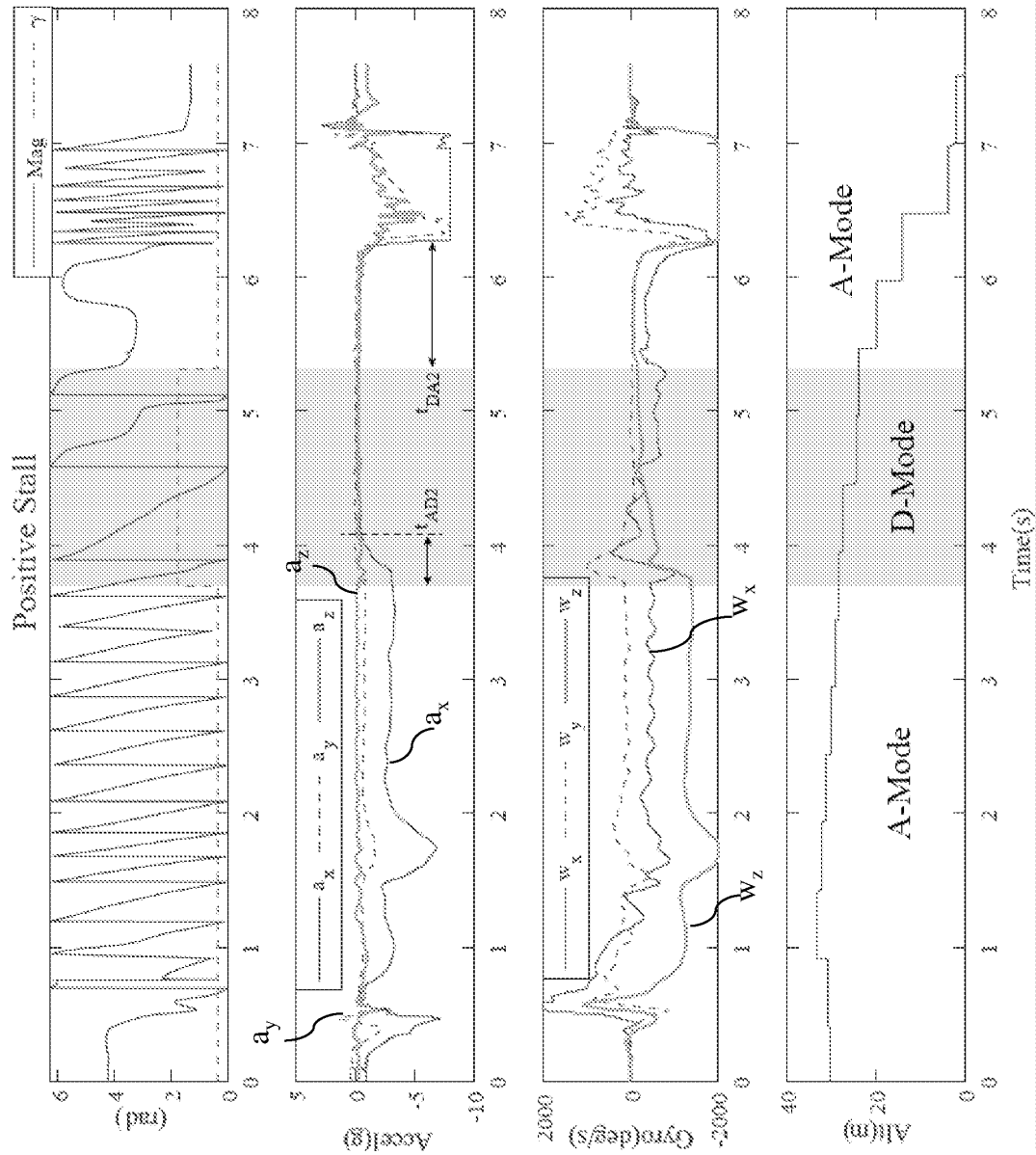


FIG. 17B



FIG. 18

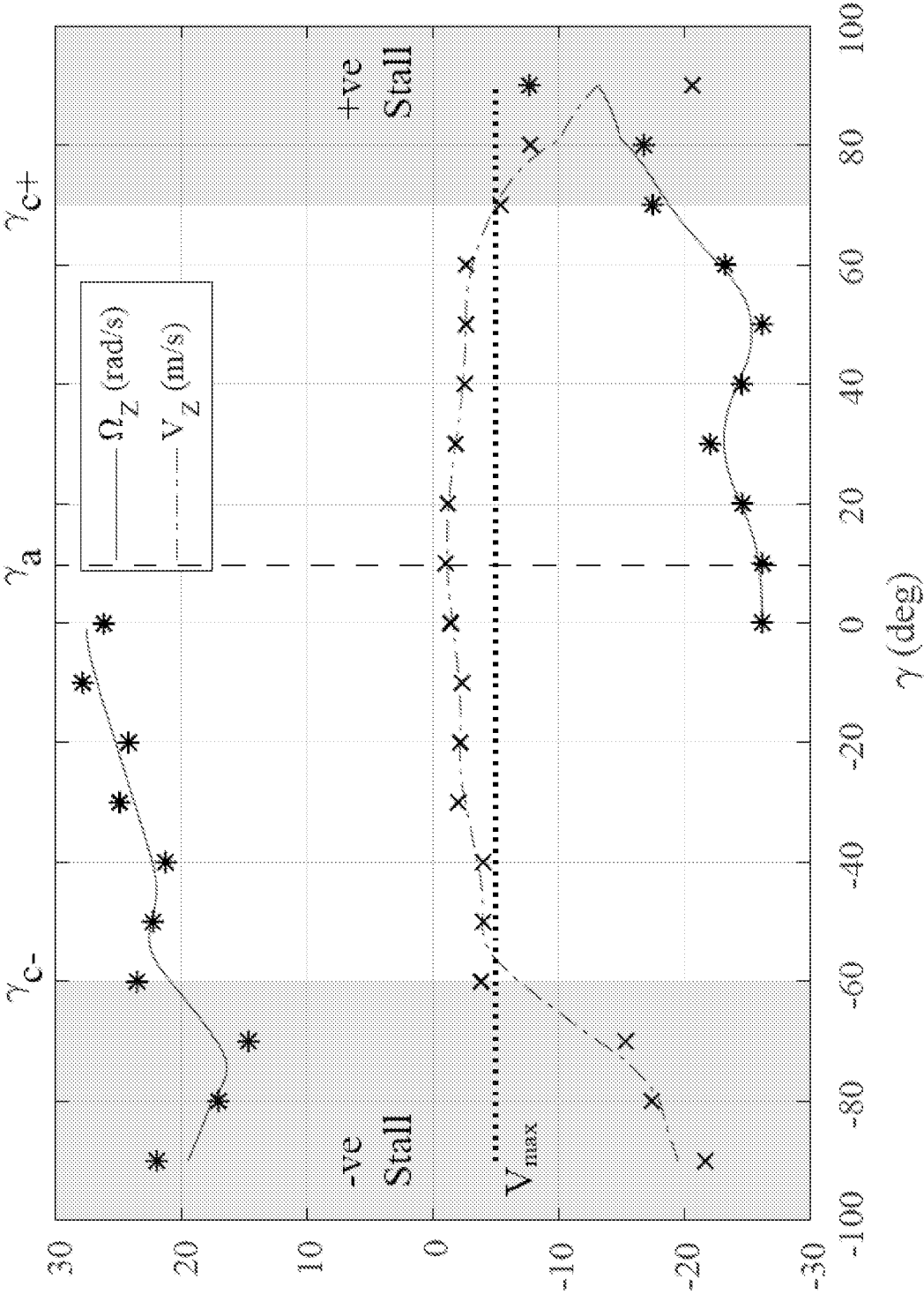


FIG. 19

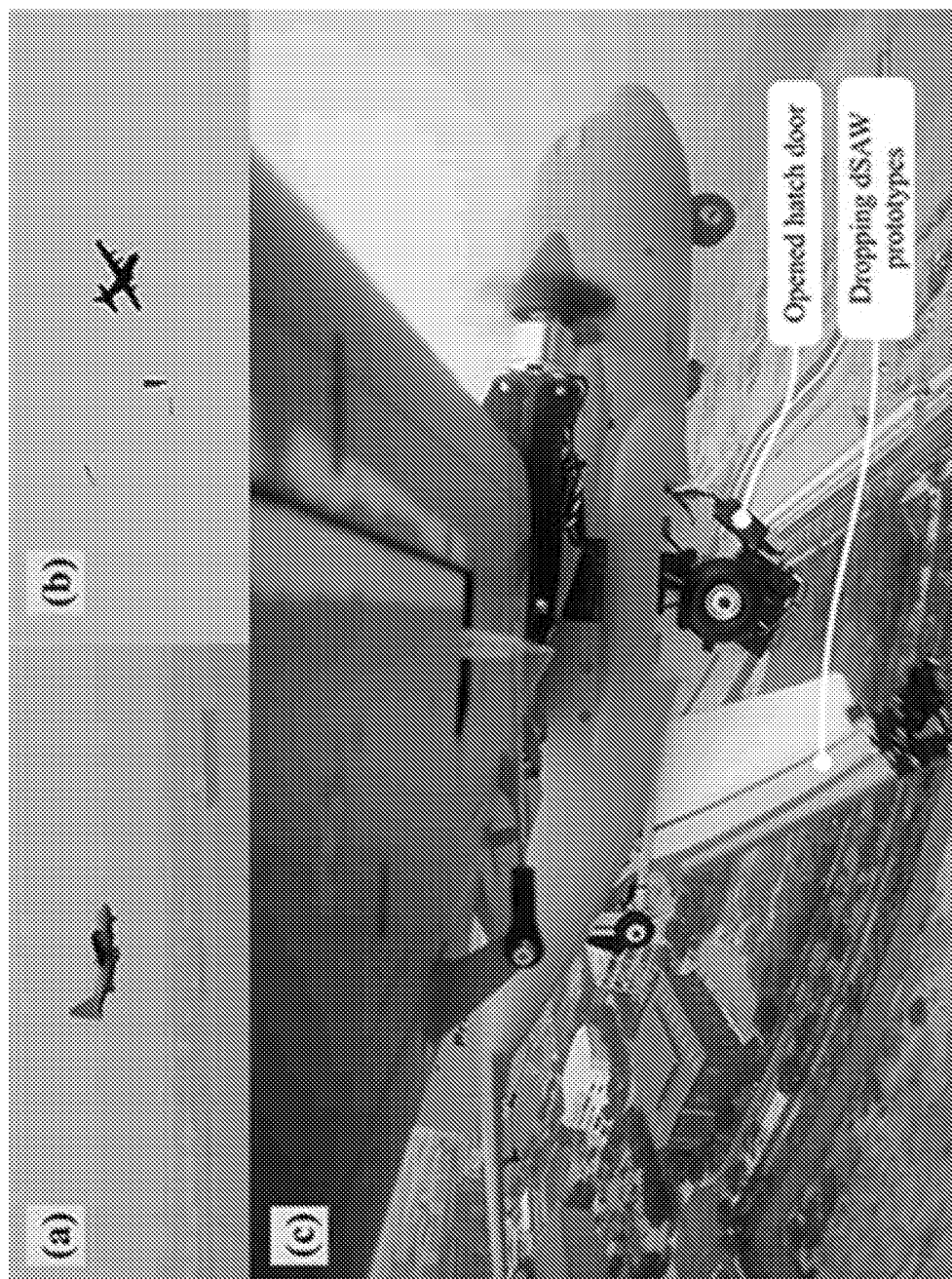


FIG. 20

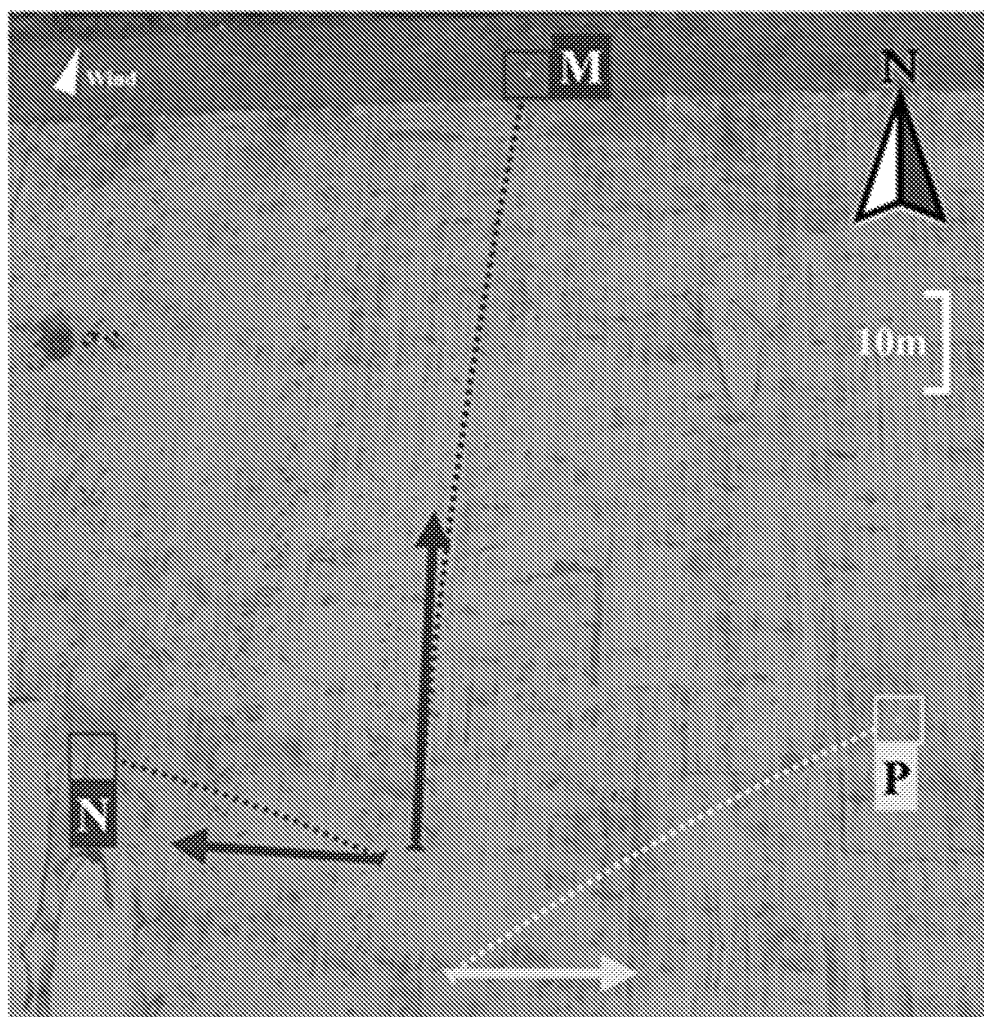


FIG. 21

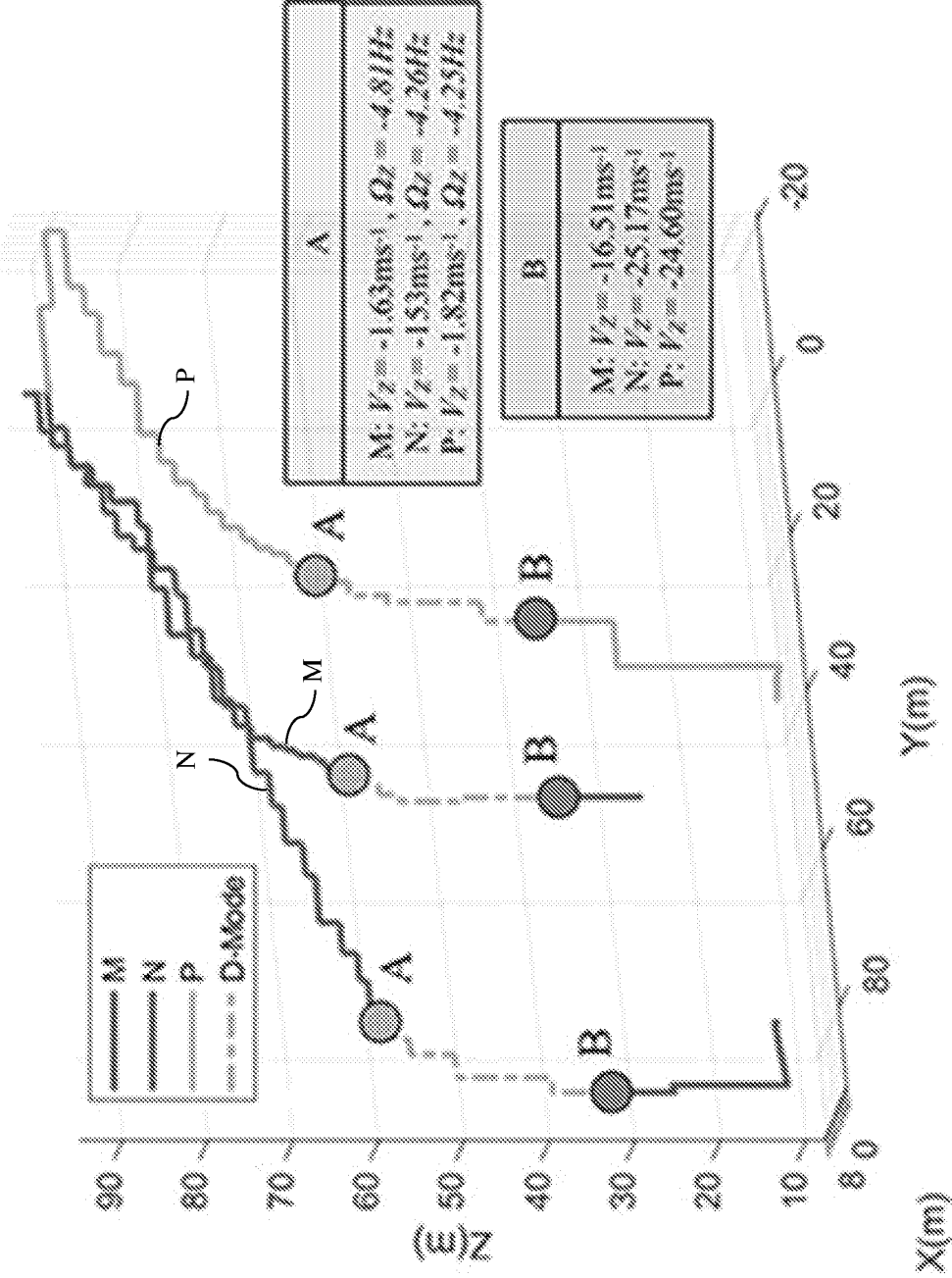


FIG. 22

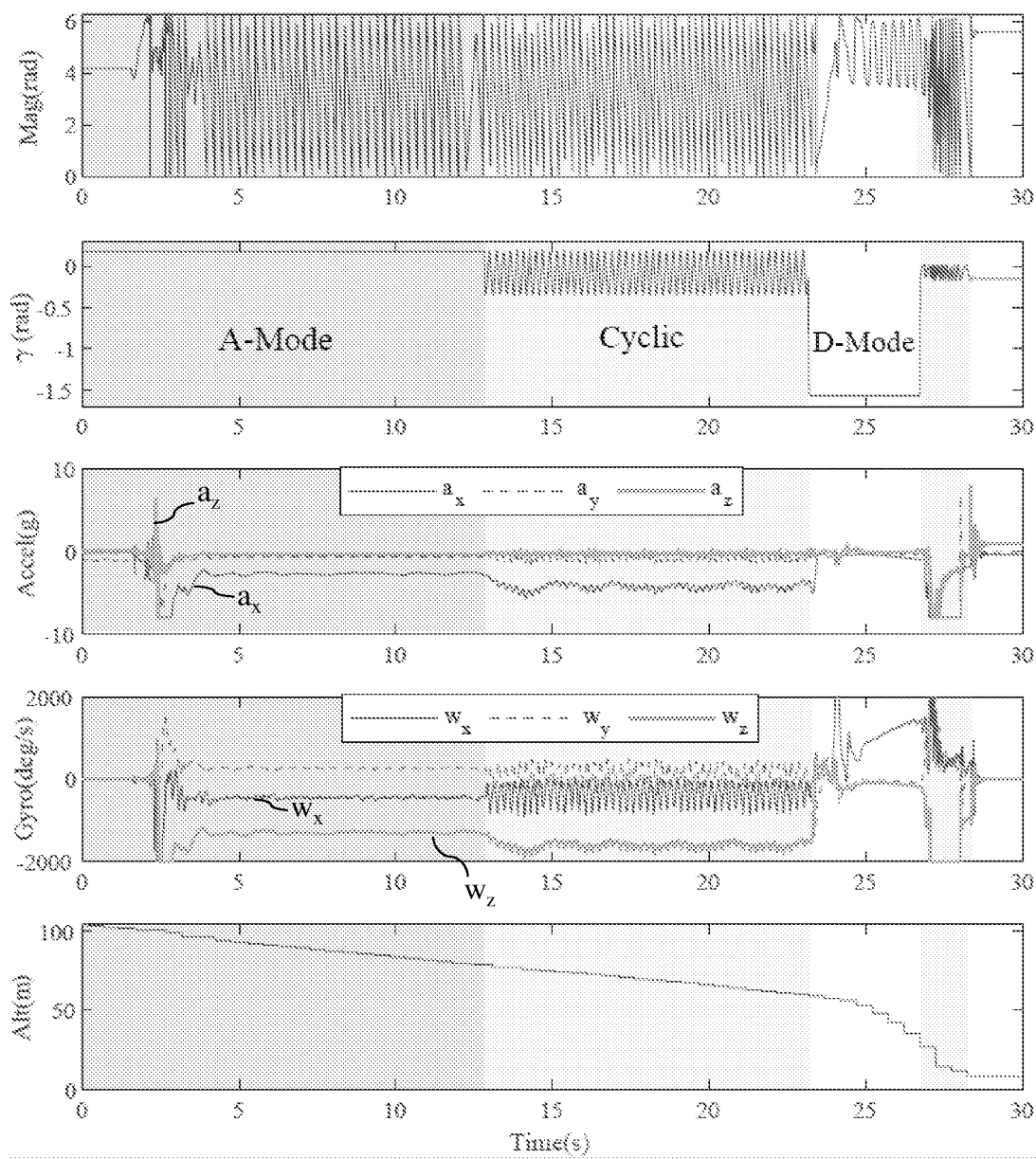


FIG. 23

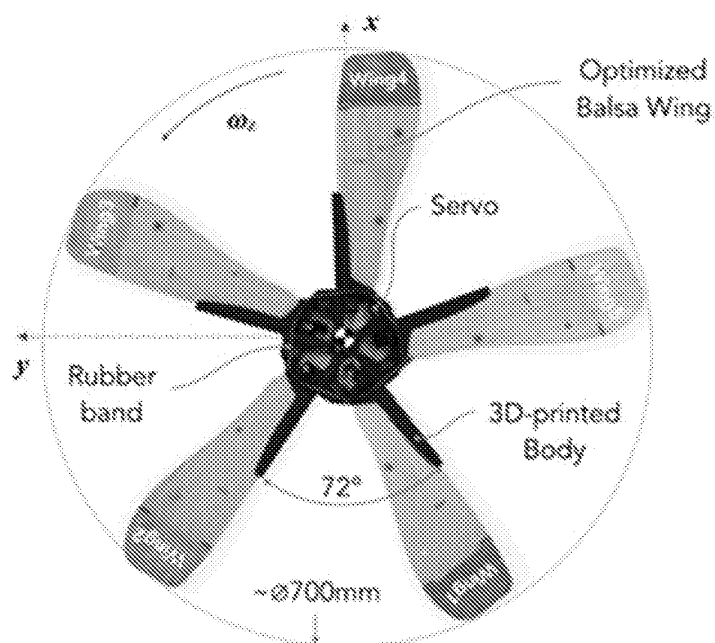


FIG. 24A

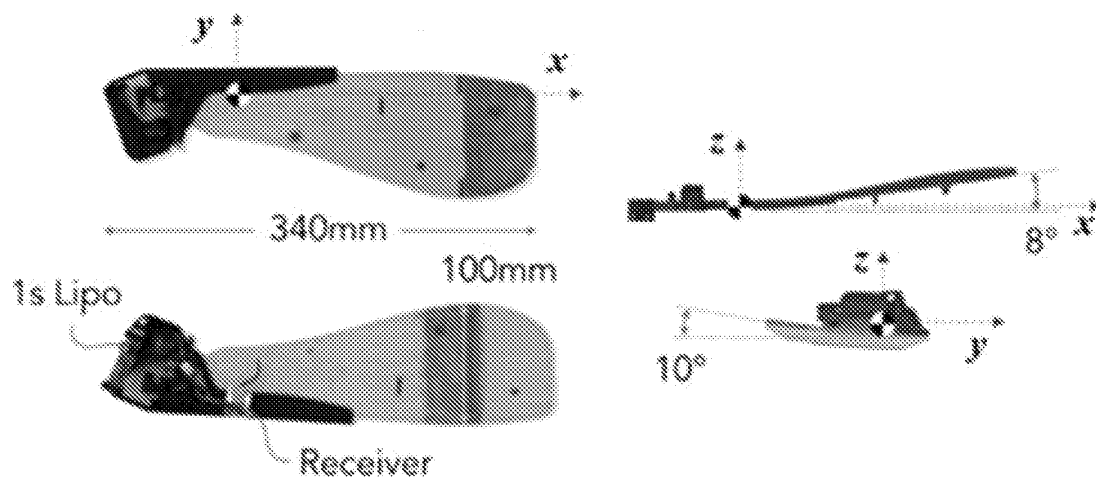


FIG. 24B

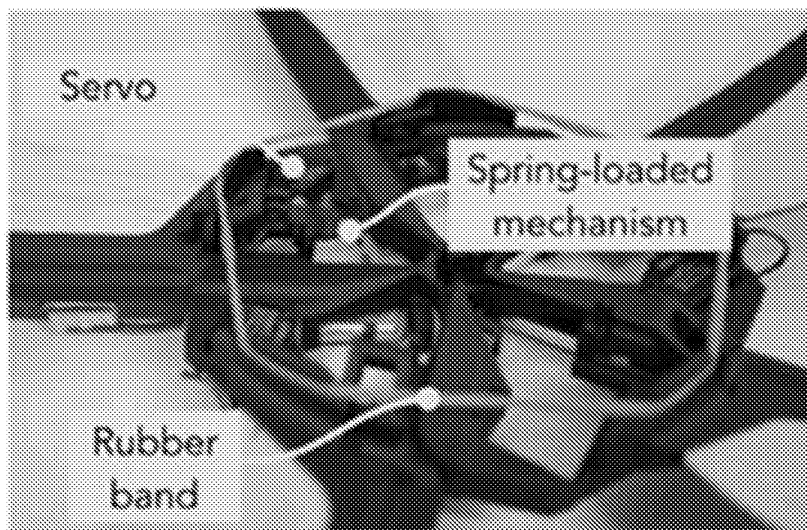
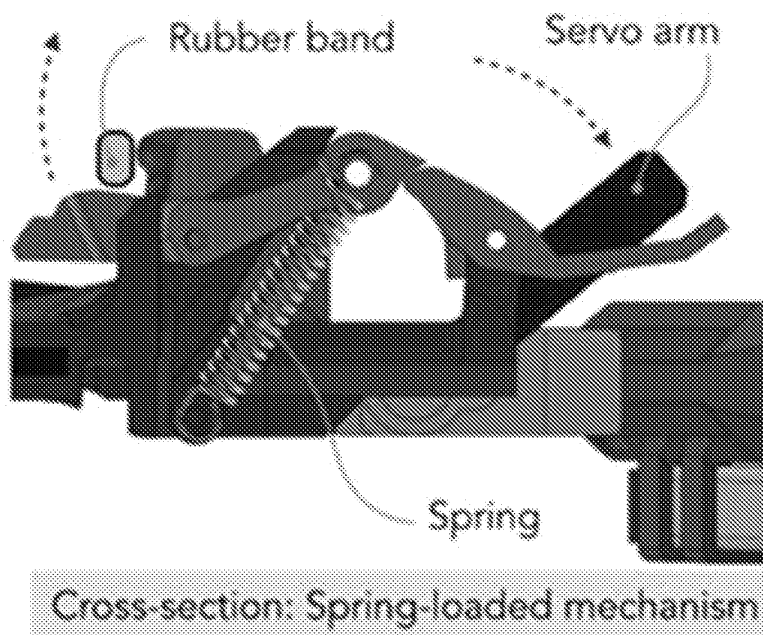


FIG. 24C

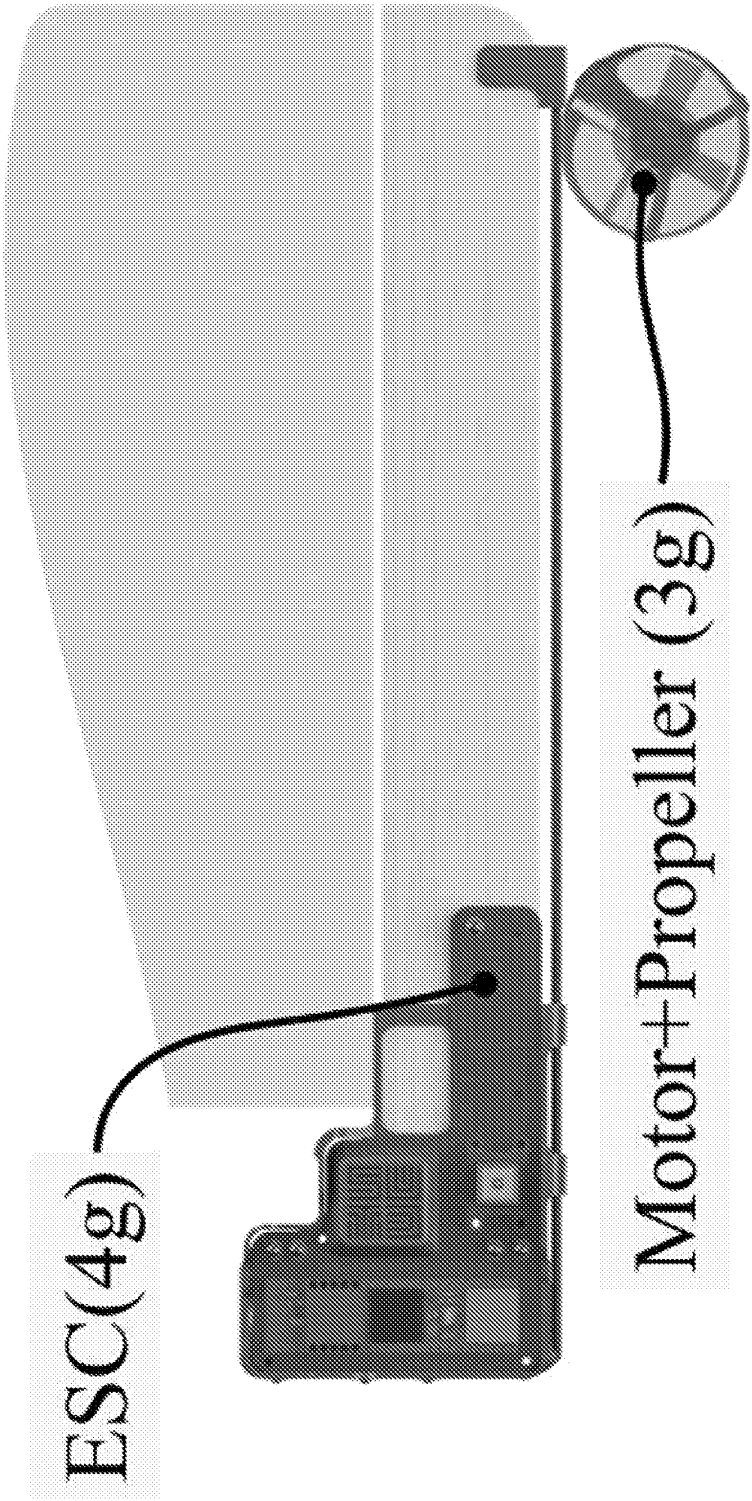


FIG. 25

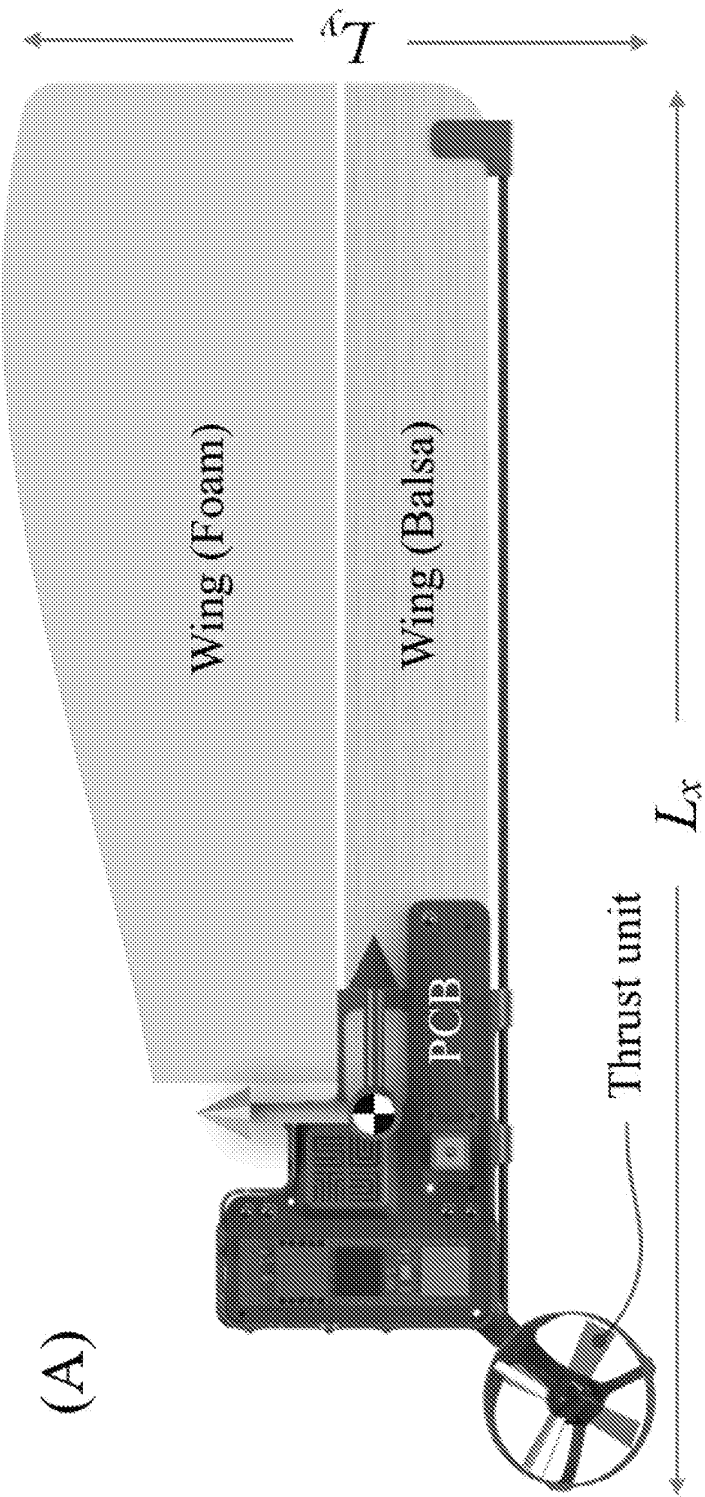


FIG. 26A

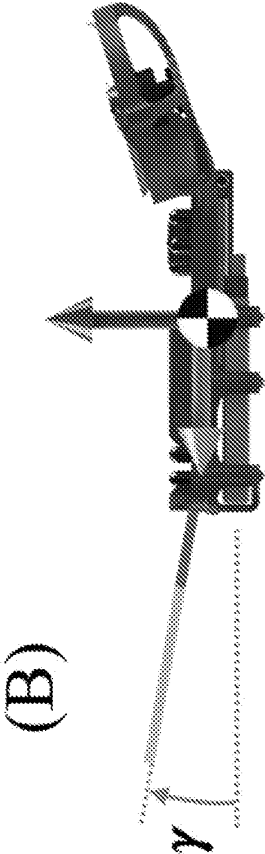


FIG. 26B

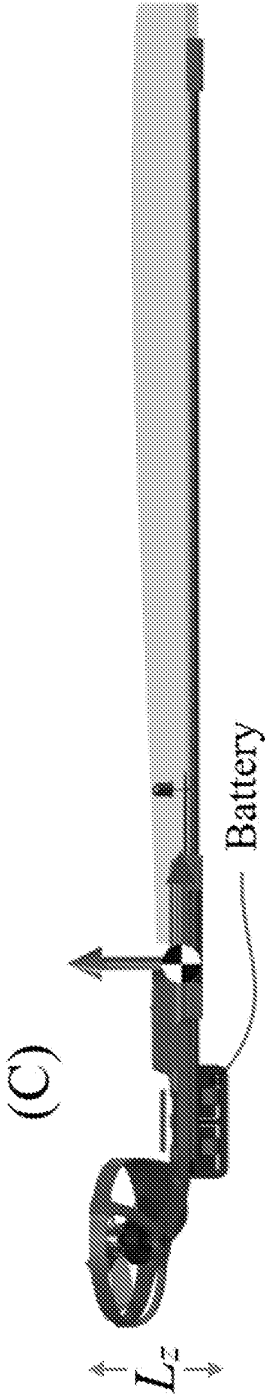


FIG. 26C

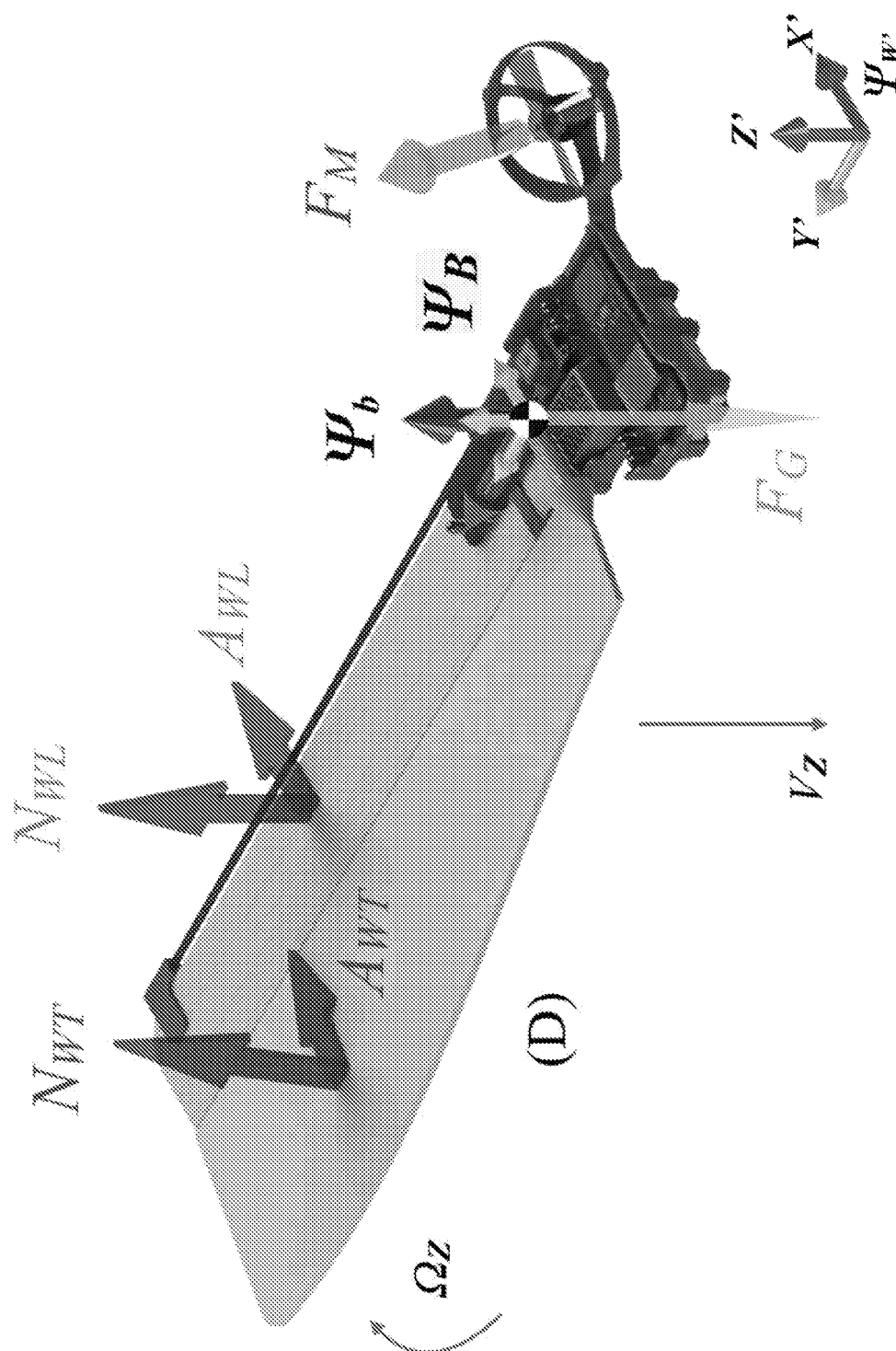


FIG. 26D

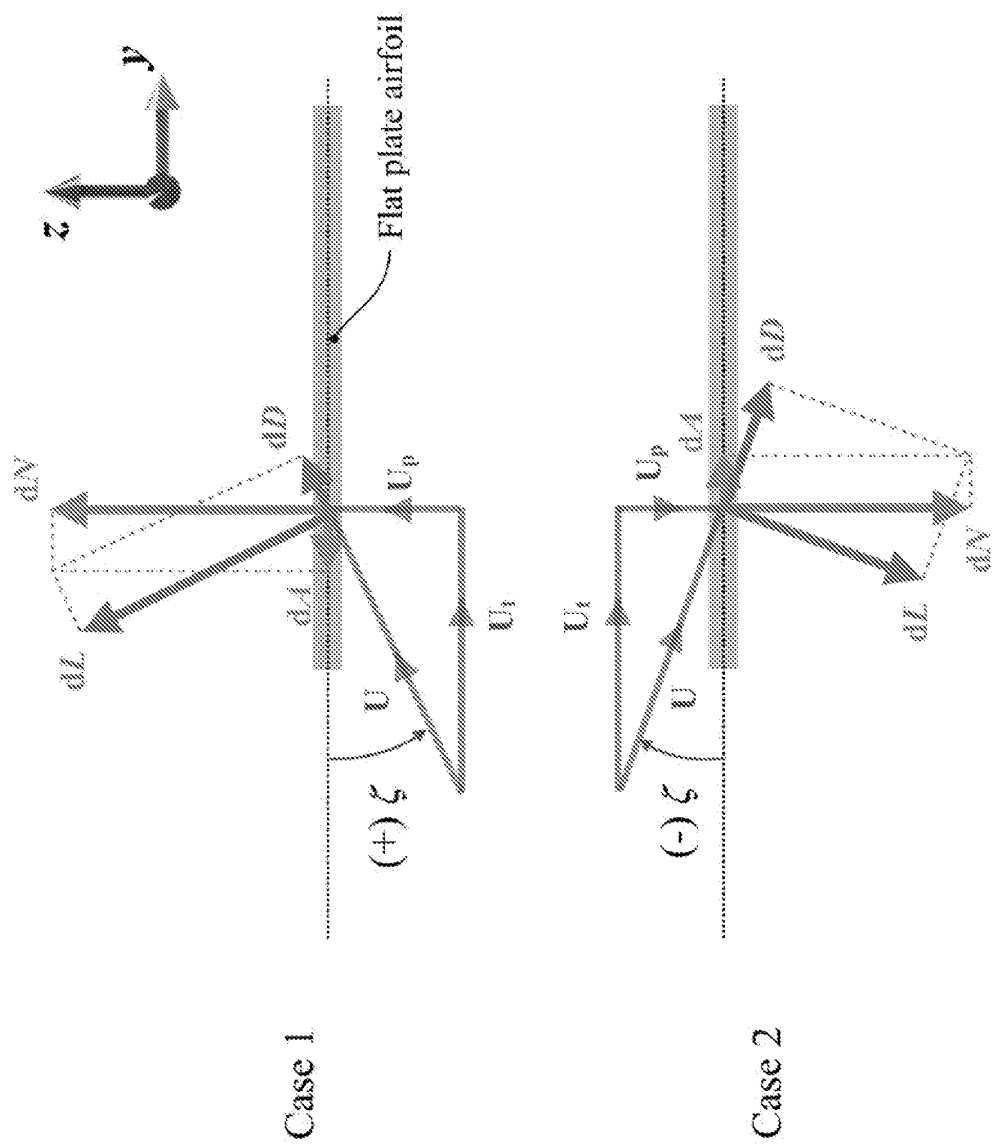


FIG. 27

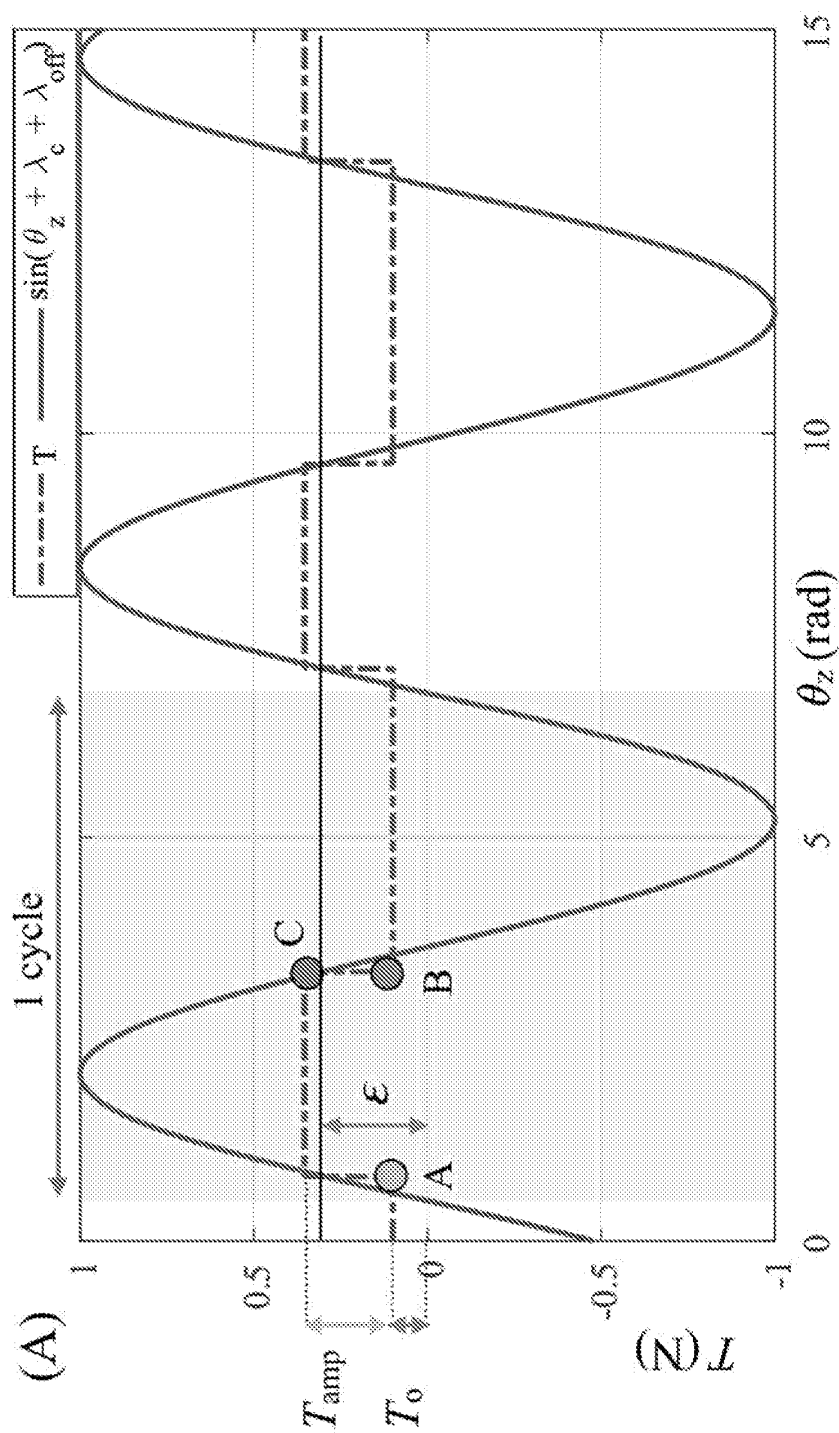


FIG. 28A

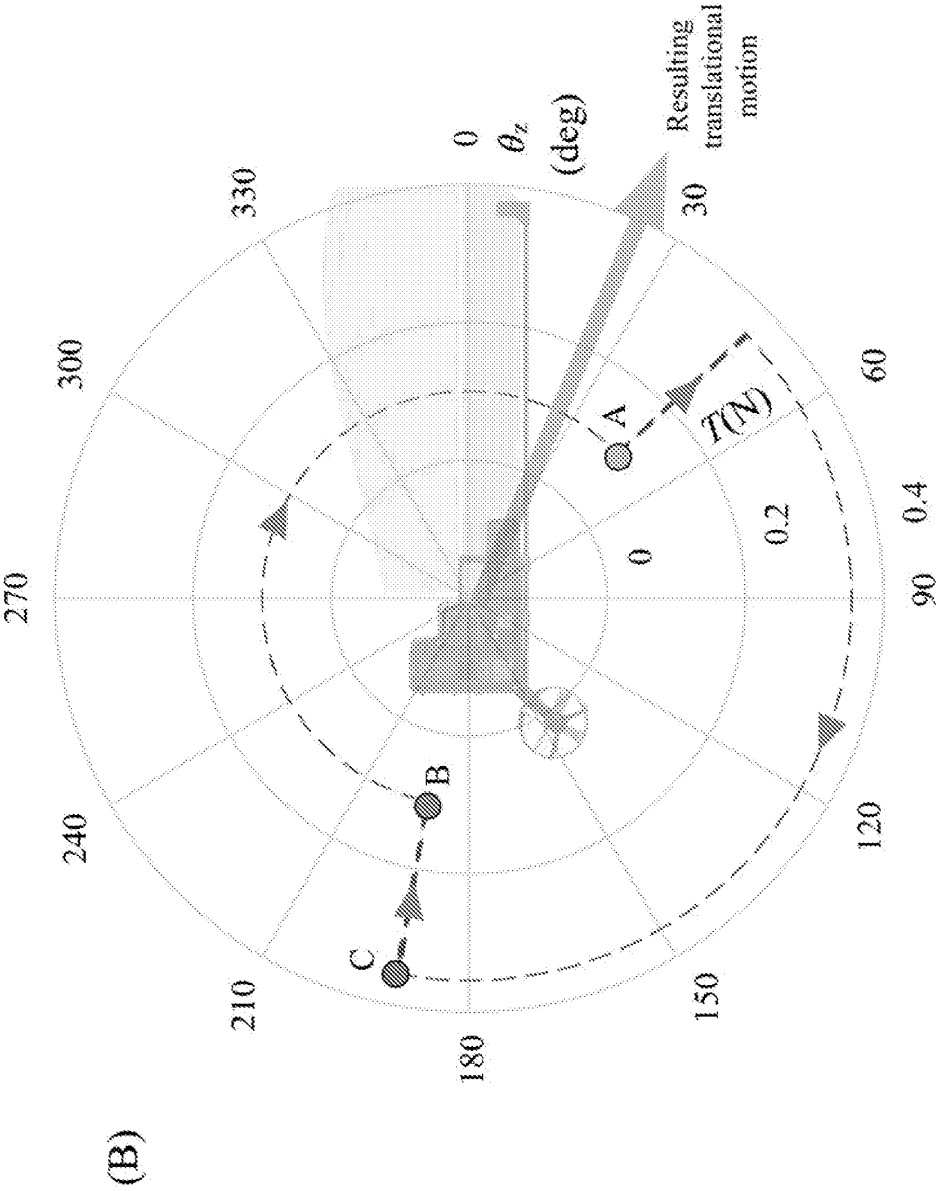


FIG. 28B

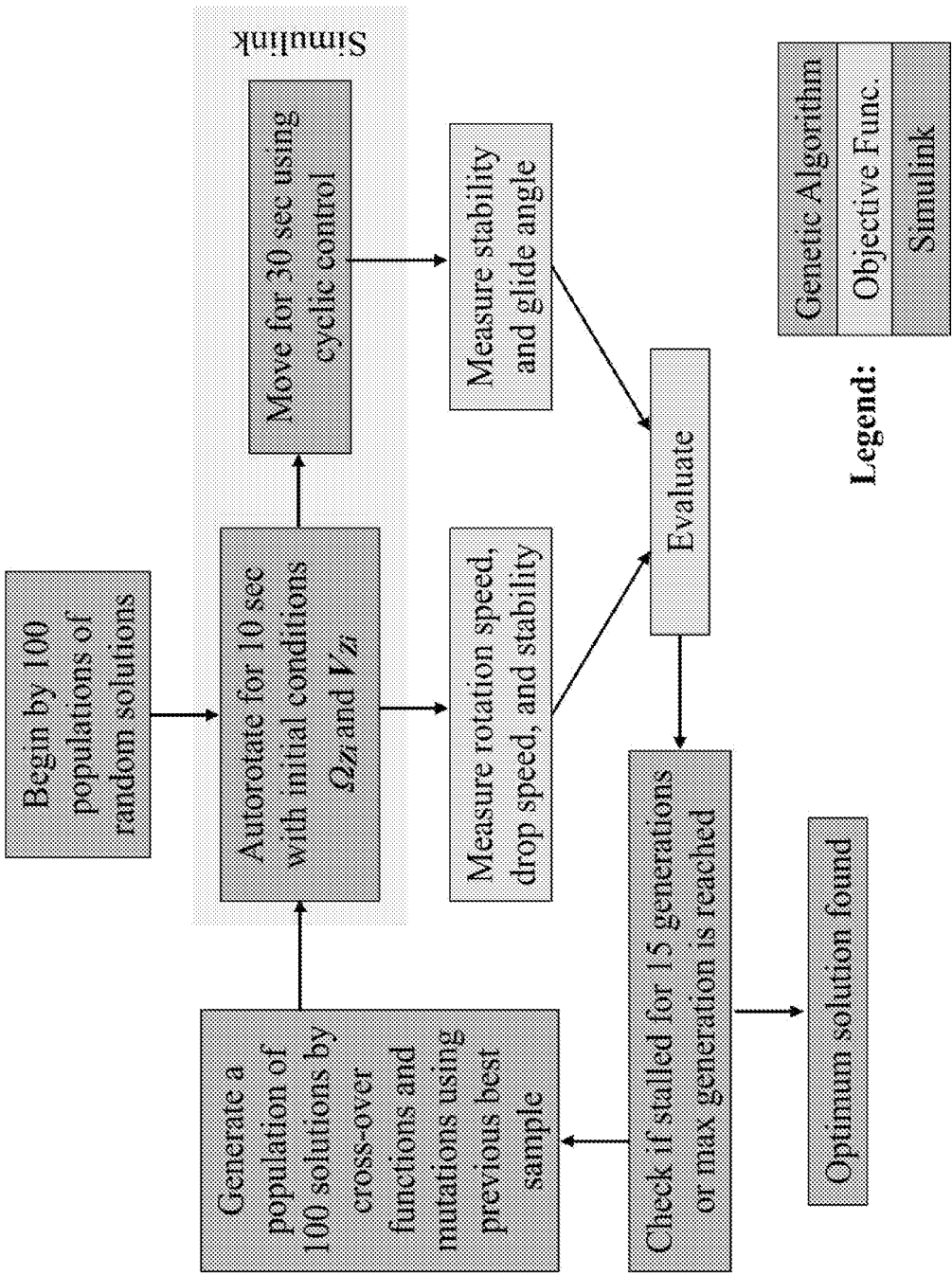


FIG. 29

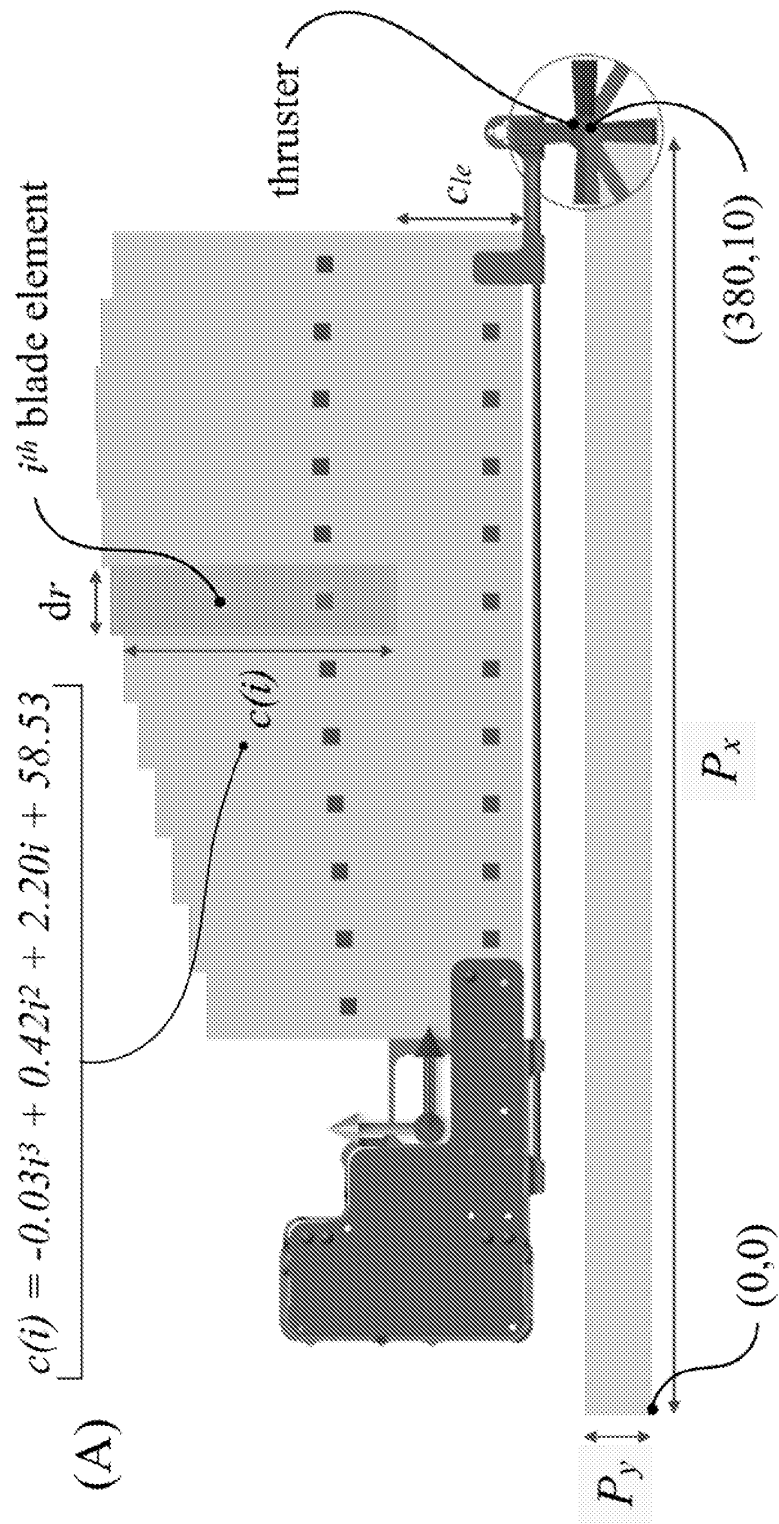


FIG. 30A

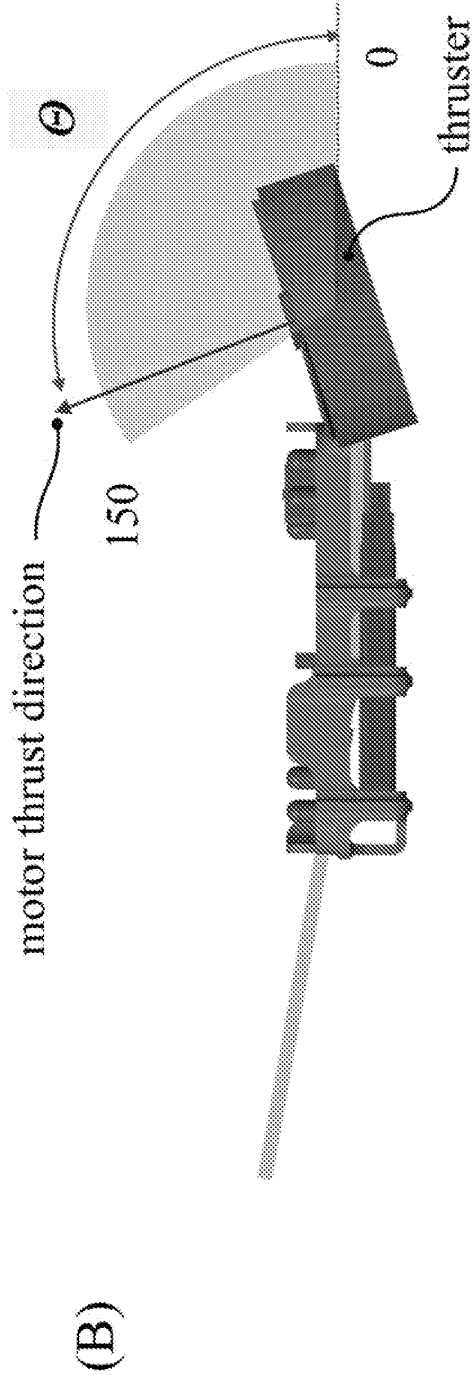


FIG. 30B

Table 6 TABLE OF SIMULATION PARAMETERS

PARAMETERS	
Environment	$\rho_{air} = 1.225\text{kg/m}^3, g = -9.81\text{m/s}$
Initial conditions	$V_Z = 0\text{m/s}, \Omega_Z = -18.85\text{rad/s}$
Objective fn coeffs	$\kappa_1 = 50, \kappa_2 = 20, \kappa_3 = 20,$ $\kappa_4 = 350, \kappa_5 = 800$
Others	$n_1 = 3000, n_2 = 9999, n_3 = 2000,$ $n_4 = 10000, n_5 = 40000$ $t_s = 10\text{s}, t_f = 40\text{s}$ $n_{be} = 12$
OPTIMIZED DESIGN VARIABLES	
Parameters	$P_x = 25\text{mm}, P_y = 5\text{mm}, \Theta = 106^\circ,$ $T_o = 0.0761\text{N}, T_{amp} = 0.3104\text{N},$ $\epsilon = -0.0087$
Others	$\gamma = 0.174\text{rad}, m = 68\text{g}$ $L_x = 350\text{mm}, L_y = 177\text{mm}, L_z = 39\text{mm}$

FIG. 31

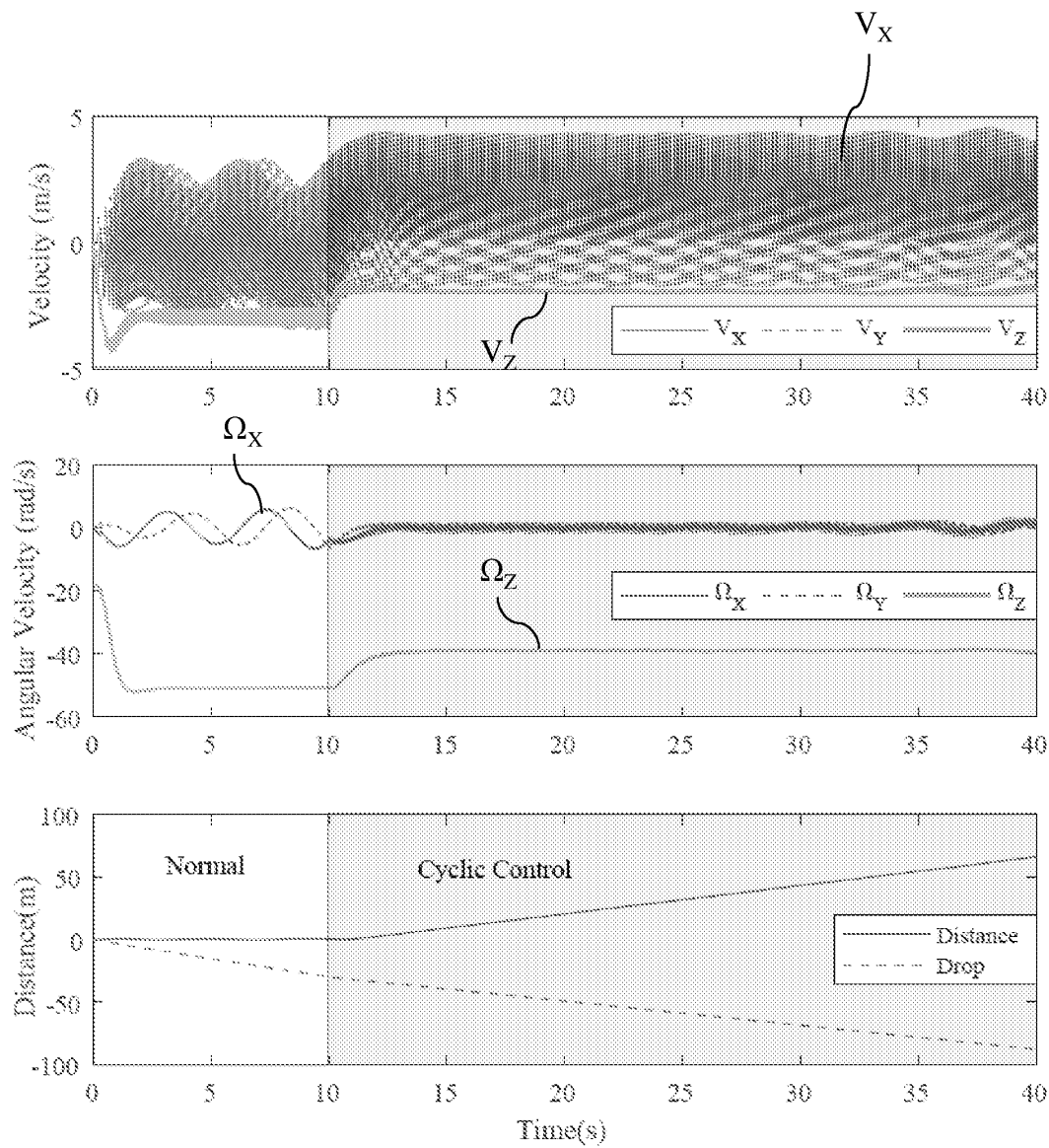


FIG. 32

Control Strategy	Thruster Config				
	Optimized			Arbitrary	
Square Cyclic	O1	[25, 5, 106] $GS = 40.91^\circ$ $t_s = 16.83s$	A1	[10, 360, 0] $GS = 41.15^\circ$ $t_s = 29.75s$	
Sine Cyclic	O2	[25, 5, 106] $GS = 58.90^\circ$ $t_s = 26.88s$	A2	[10, 360, 0] $GS = 60.33^\circ$ $t_s = 39.98s$	

FIG. 33

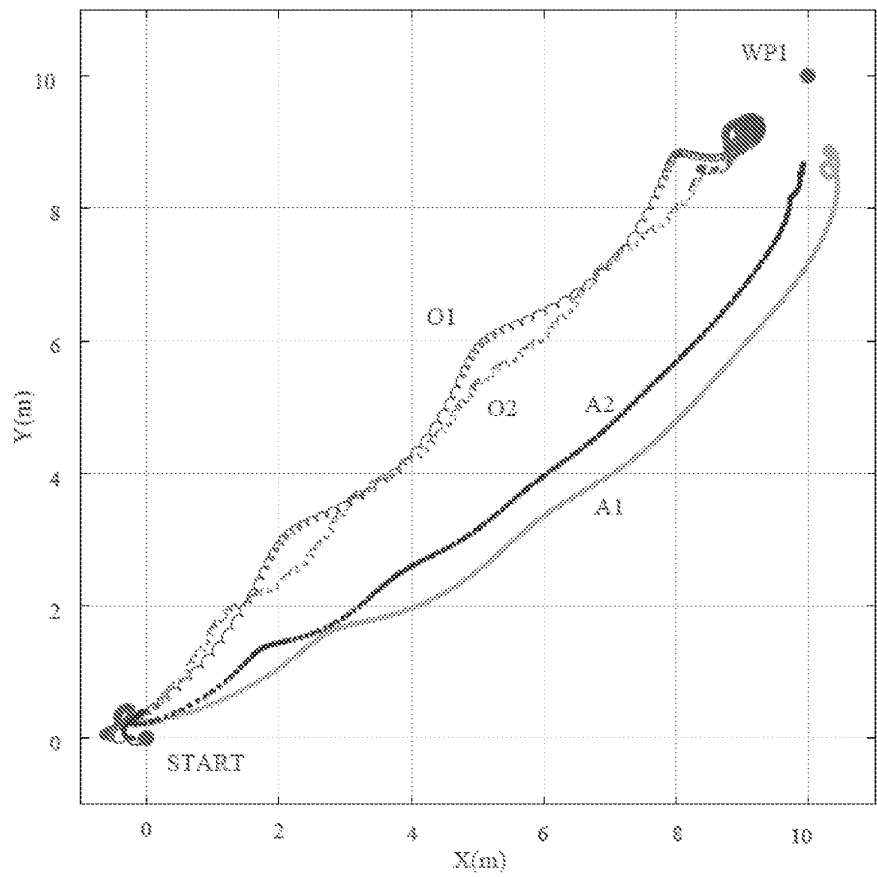


FIG. 34A

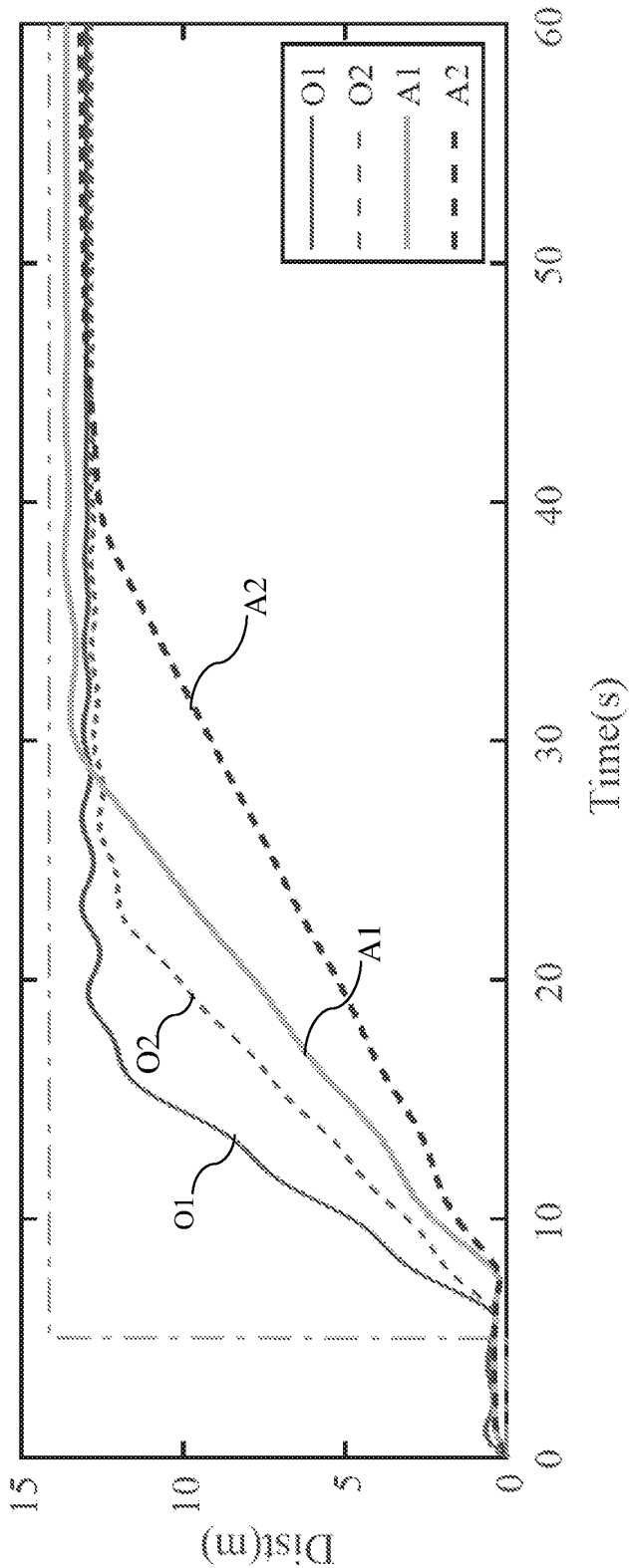


FIG. 34B

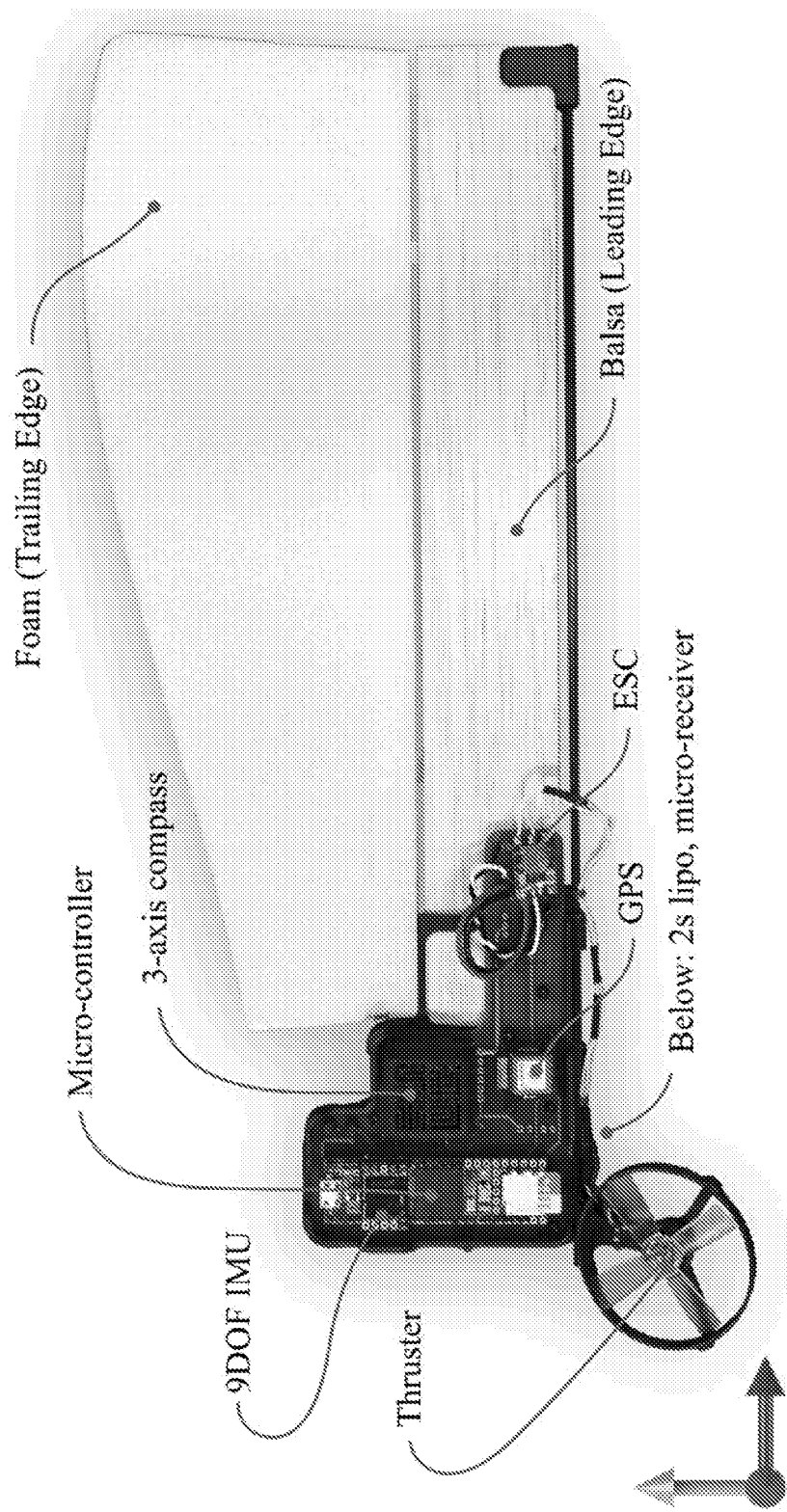


FIG. 35

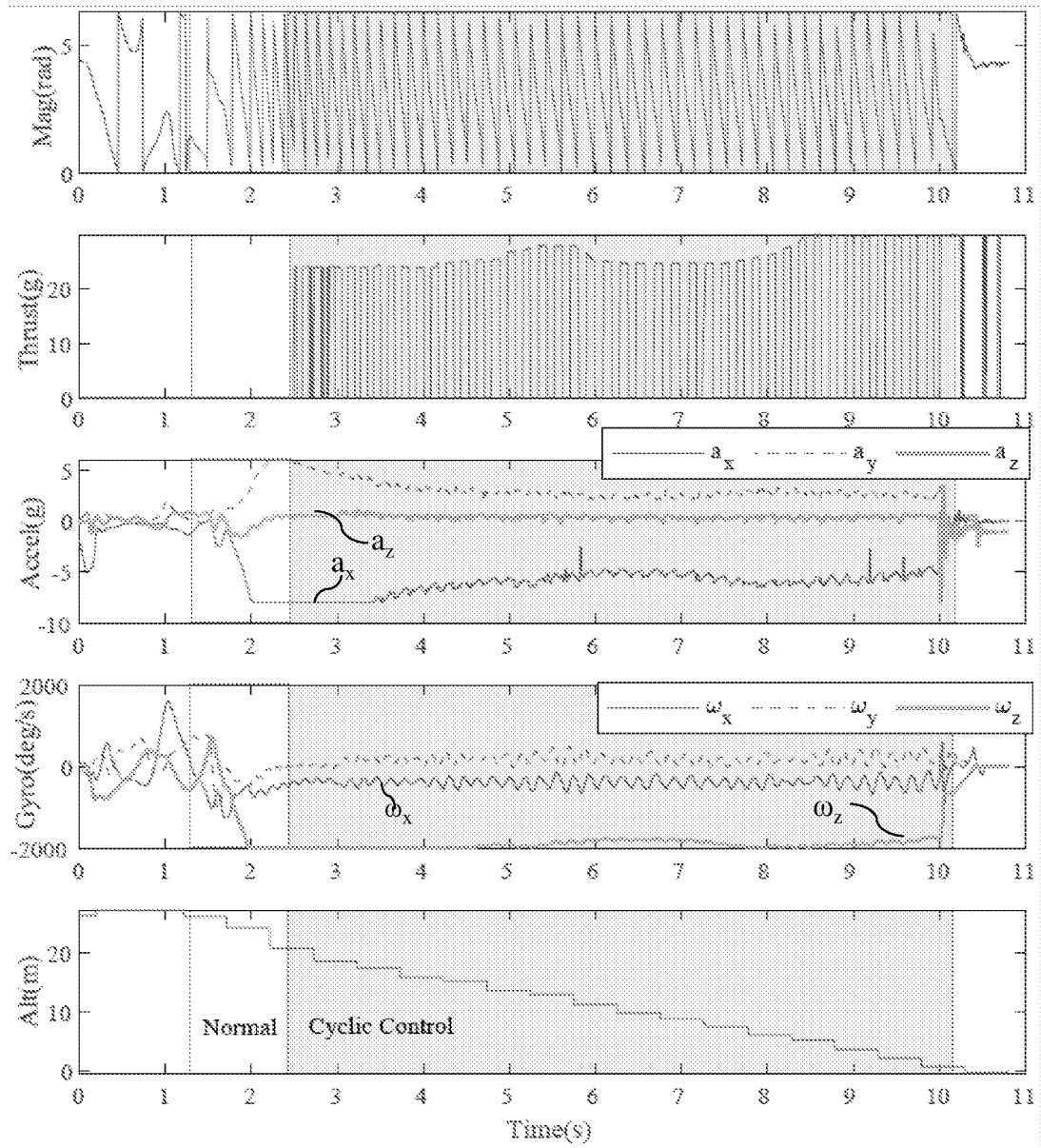


FIG. 36



FIG. 37