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Robust Backstepping Sliding Mode Control for a Morphing Quadcopter UAV

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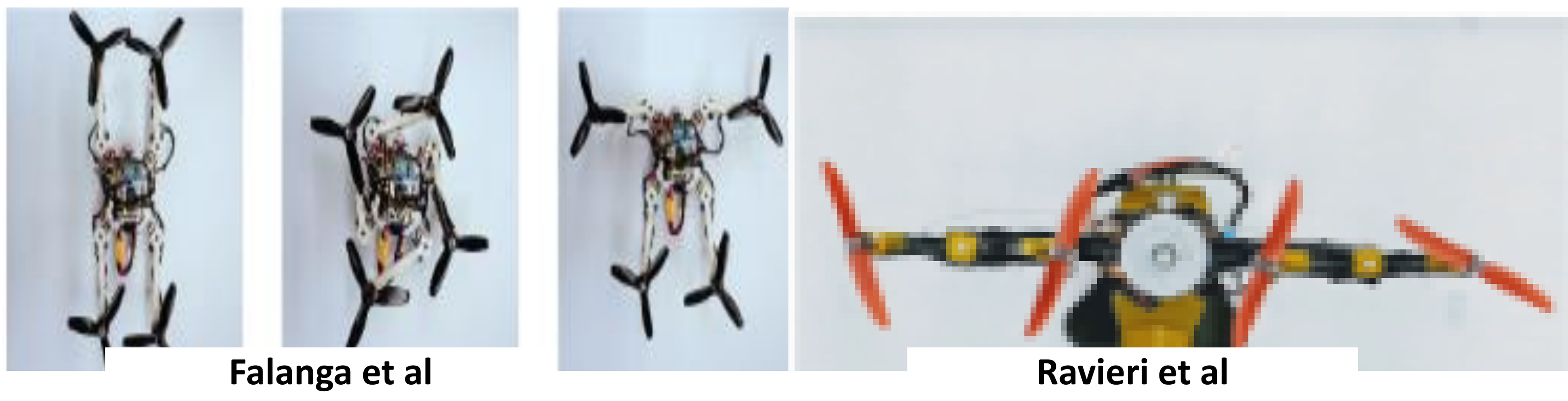
INTRODUCTION & AIM

Introduction:

Morphing Quadcopters are aerial robots that can change configuration inflight. The robot has many applications and advantages over conventional quadcopter.



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Problem Statement:

Because of geometric reconfiguration, morphing quadcopter dynamics has parameter variations which increase the complexity of control design in addition to nonlinearity, parametric and nonparametric uncertainties.

Aim and Objectives

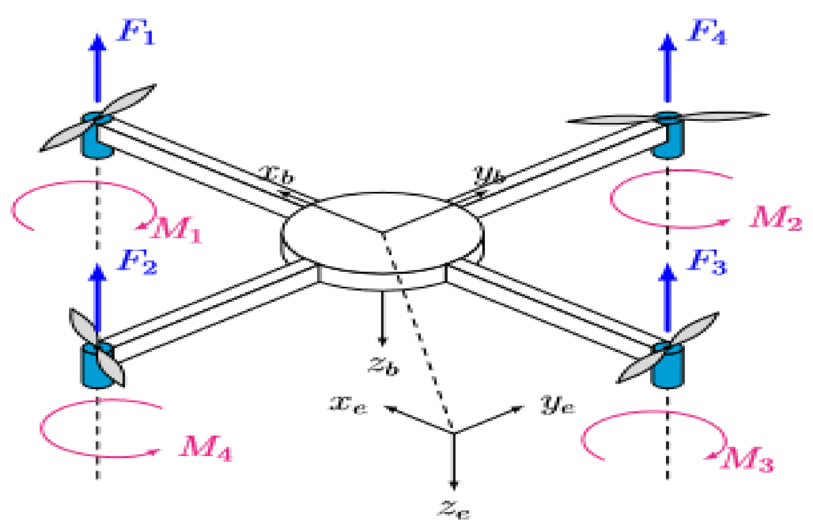
The aim of this research is on developing a robust backstepping sliding mode control for morphing quadcopter UAV. The stated aim will be achieve through the following objectives:(a) Modelling of morphing quadcopter with five morphing formations (d) Development of robust backstepping slide mode control (c) Evaluating and benchmarking the developed control strategies against BSC using MSE, IAE, settling time, and deviation as performance metrics.

METHOD

System Modelling

The model of the system is developed through the following steps;

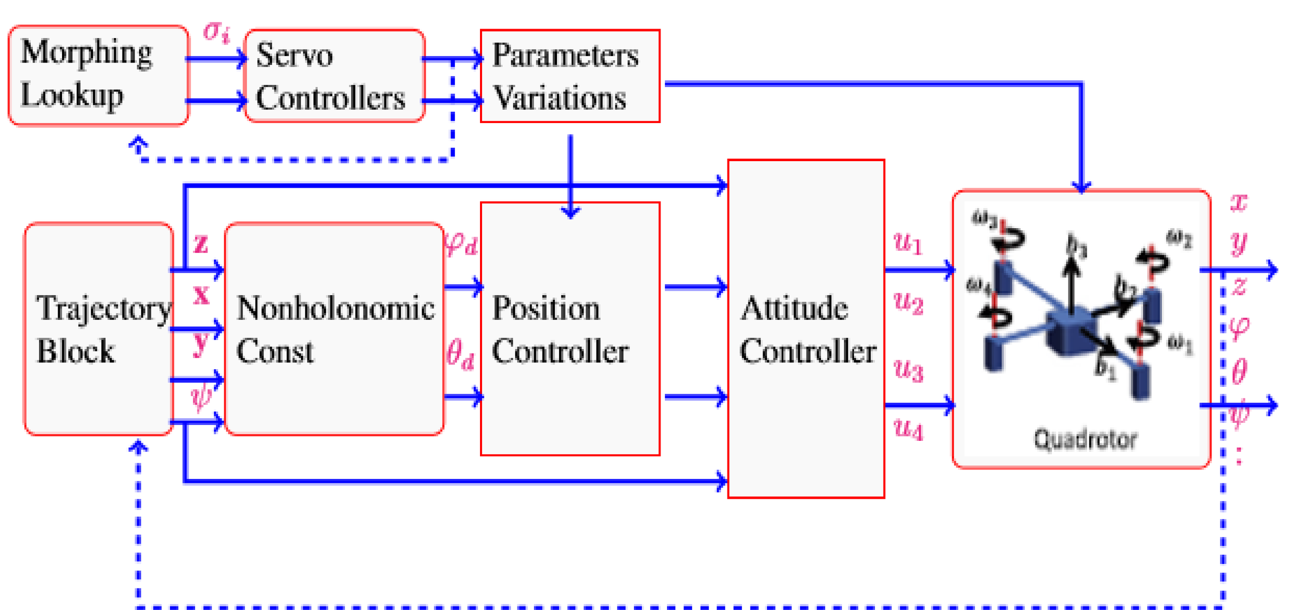
a. Develop the physical model with five morphing formations (X, Y, H, T, O)
b. Obtain center of gravity, arm position vectors, and inertia tensor variations expression
c. Using obtained expressions in (b) to generate the complete dynamic equations of the system



Control Design

The control structure of BSMC is as in Fig.3. The control laws are obtain through the following steps

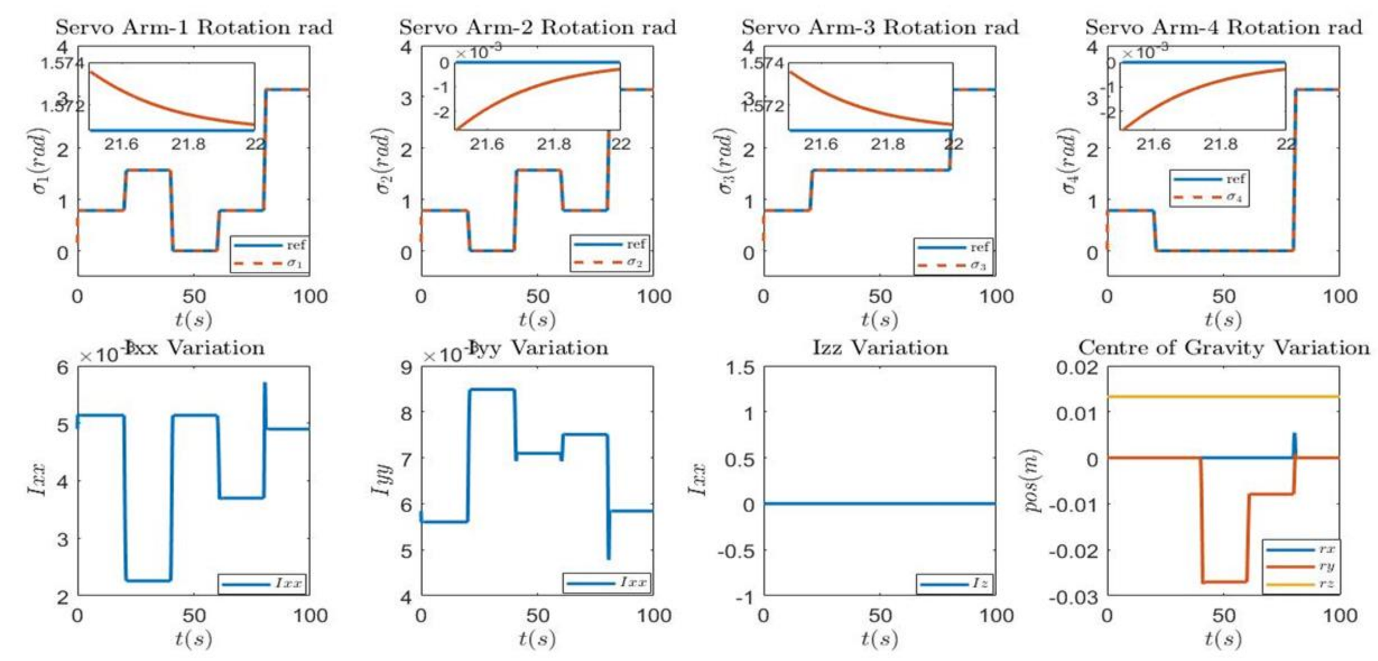
a. For precise arm positioning, PID servo control was designed
b. Based on model parameter variations, control allocation matrix was obtained
c. Define the control errors for position and orientation and Lypunov candidate
d. Using Lypunov to obtain the control laws for position and orientation



RESULTS & DISCUSSION

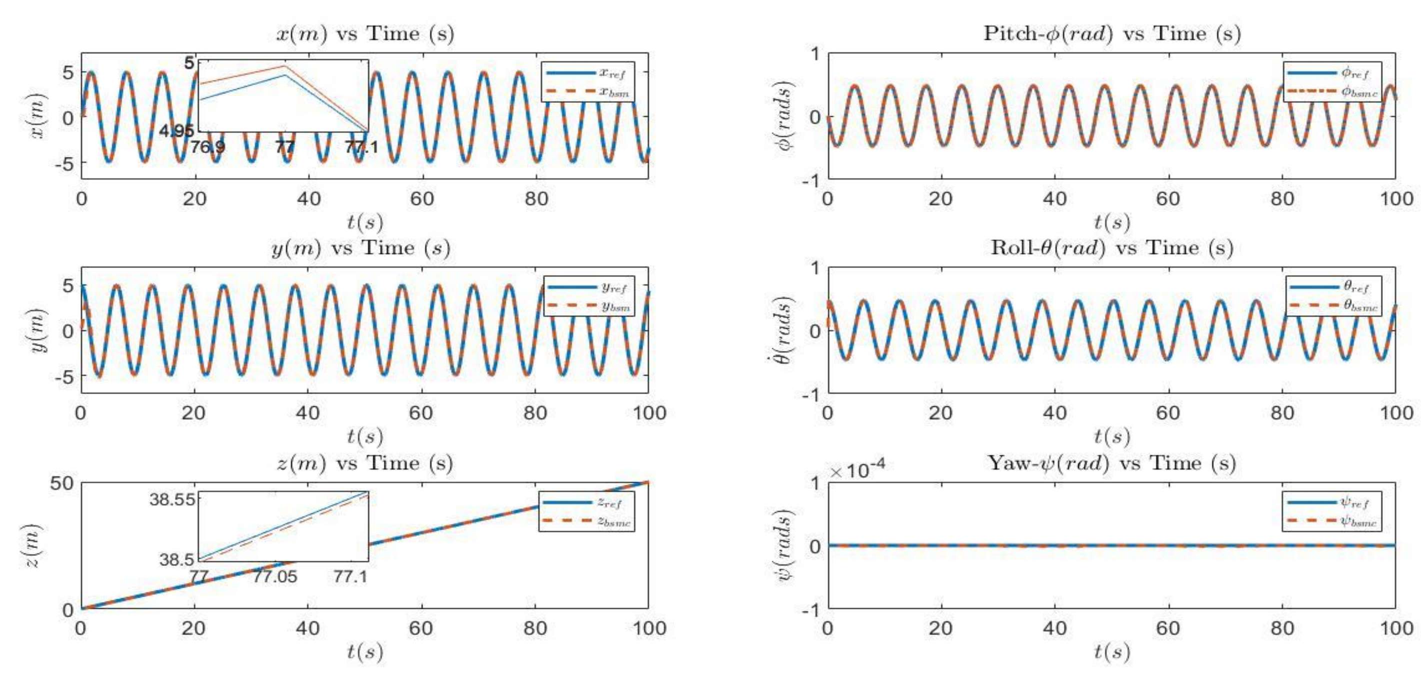
Arm Servo Control

For precise control of the arms positions, PID controller has been designed. The morphing quadcopter was set to change formations every 20 second simulation time and the results is as presented in Fig.

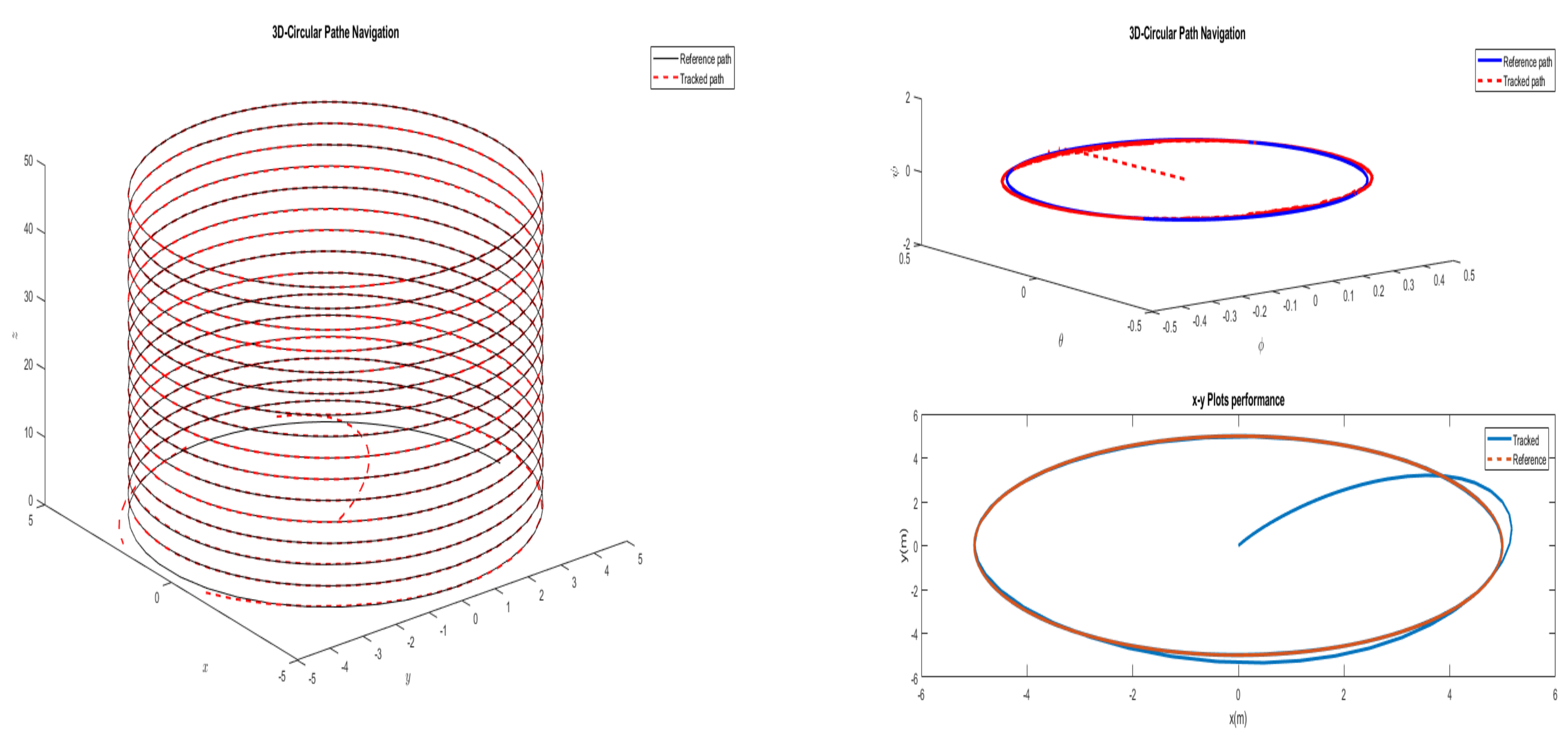


Position and Orientation Control

The BSMC Position and orientation performance is as presented in Fig



3D-Position and Orientation Plots



CONCLUSION

This research has developed physical and mathematical models of morphing quadcopter with five morphing configurations. Because of parameter variations and uncertainties, Backstepping sliding mode control was developed using Lyapunov for controlling the vehicle. The developed control approach was evaluated against backstepping control and found to have better performance

FUTURE WORK / REFERENCES

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