**Introduction:**

Multi-rotor sUAS may be guided to passively track and follow another small Unmanned Aerial Systems (sUAS).

On-board direction and ranging sensor technology for sUAS currently only provides a highly uncertain position estimation.

Proportional navigation guidance has been used by missiles to track targets. PN guidance may be useful for guiding a mutli-rotor sUAS to intercept and follow other sUAS.

Interception and following has applications in autonomous flight formation and swarming scenarios as well.

The objective was to use a modified PN guidance to track other sUAS with uncertain position information.

**Methods:**

Interceptor and target kinematics are first presented, followed by the traditional PN guidance law. Next an on-board sensor that measures the target's position, which has some uncertainty, is modeled. A state machine pseudotarget is introduced that prevents the intercepting UAV from entering the uncertain area while accomplishing the main goal of intercepting and following the target. Simulations were performed to validate the model and to show that the following distance can be predicted from the initial LOS angle, range, and sensor characteristic.

**Conclusion:**

A pseudotarget based proportional navigation (PN) guidance algorithm that directs a UAV to intercept and follow a target UAV using highly uncertain sensor position information was investigated.

Simulations were performed to determine the following distance for a finite space.

Near zero following distance was achievable for a finite range of initial headings and sensor $dr$'s. Following distance to initial range ratios indicate that the modified guidance performs optimally when the initial LOS angle is less than $45^\circ$ and larger initial sight angles may benefit from other intercept methods.

The state machine pseudotarget PN guidance algorithm was specifically designed to intercept and follow an inbound non-maneuvering target for the edge case of $1:1$ speed ratio.

Initial results suggest that the proposed guidance is tracks the target with less error compared to traditional PN for head-on intercepts but slightly underperformed in the tail-chase scenario.

A pseudotarget proportional navigation (PN) guidance algorithm that directs a UAV to intercept and follow a target UAV using highly uncertain sensor position information was investigated. The state machine pseudotarget PN guidance algorithm was specifically designed to intercept and follow an inbound non-maneuvering target for the edge case of $1:1$ speed ratio. Simulations were performed to determine the following distance for a finite space. Near zero following distance was achievable for a finite range of initial headings and sensor $dr$'s. Following distance to initial range ratios indicate that the modified guidance performs optimally when the initial LOS angle is less than $45^\circ$ and larger initial sight angles may benefit from other intercept methods. Initial results suggest that the proposed guidance is tracks the target with less error compared to traditional PN for head-on intercepts but slightly underperformed in the tail-chase scenario

**New Introduction**

Summary of problem

Summary of current methods

Description on why current methods are not valid

Broad statement of what was accomplished

Paper description

What is the motivation. . .

Tracking and following small unmanned systems (sUAS) have applications in autonomous flight formation, swarming, and standoff target tracking. Multi-rotor sUAS may also be guided to passively track and follow another target sUAS flying in restricted airspace. Path planning, heading control laws, and line-of-sight (LOS) guidance algorithms have been proposed for intercepting and following moving targets. Path planning is typically performed at a ground station requiring constant communication to adapt for a moving target. Control laws for target tracking rely on low uncertainty target position estimates. Line-of-sight methods such as proportional navigation (PN) guidance have been used in missile systems to track targets but may fail to follow a target under head-on intercept scenarios. Direction and range to the target can be measured with on-board sensors but provide highly uncertain estimates due to limitations in the sensing technology. A pseudotarget PN guidance algorithm that directs a sUAS to intercept and follow a target sUAS using uncertain position information was investigated. First the interceptor and target kinematics are presented along with the unmodified PN guidance algorithm. Next an on-board sensor that measures the target's position, which has some uncertainty, is modeled. A state machine pseudotarget is than introduced that intercepts and follows a target with high position uncertainty for head-on and tail-chase scenarios. Simulations were performed to validate the model and to show that the following distance can be predicted from the initial LOS angle, range, and sensor characteristic.

Track and follow other sUAS with high position uncertainty

Motivation, cant track them right now, high uncertainty

Potential impact, aerial interception