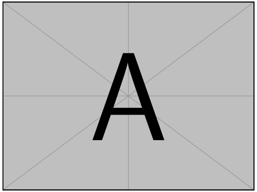
Main Title

Subtitle

Your Name

Chair: Dr.Name Name

Committee:
Dr. Name Name
Dr. Name Name
Dr. Name Name

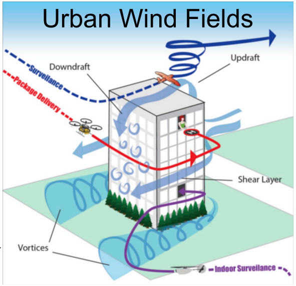


April 4, 2025

Click here to go to apendix

How can small uncrewed aerial vehicles (UAVs) more safely and efficiently navigate environments with unknown disturbances?

Disturbances



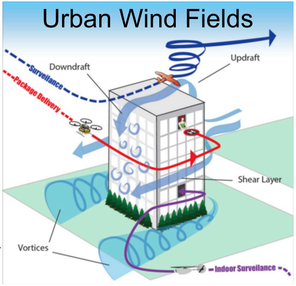
[Martin et al., 2020]
[Watkins et al., 2020]

Click here to go to apendix

How can small uncrewed aerial vehicles (UAVs) more safely and efficiently navigate environments with **unknown disturbances?**

- Uncertain disturbances - **Urban wind-fields & blasts**

Disturbances



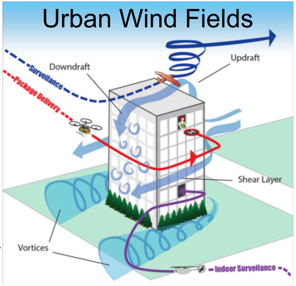
[Martin et al., 2020]
[Watkins et al., 2020]

Click here to go to apendix

How can small uncrewed aerial vehicles (UAVs) more safely and **efficiently** navigate environments with unknown disturbances?

- Uncertain disturbances - Urban wind-fields & blasts
- **Constraints - battery life & travel time**

Disturbances



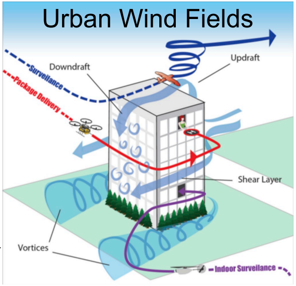
[Martin et al., 2020]
[Watkins et al., 2020]

Click here to go to apendix

How can small uncrewed aerial vehicles (UAVs) more **safely** and efficiently navigate environments with unknown disturbances?

- Uncertain disturbances - Urban wind-fields & blasts
- Constraints - battery life & travel time
- **Environmental obstacles - buildings, trees, infrastructure**

Disturbances

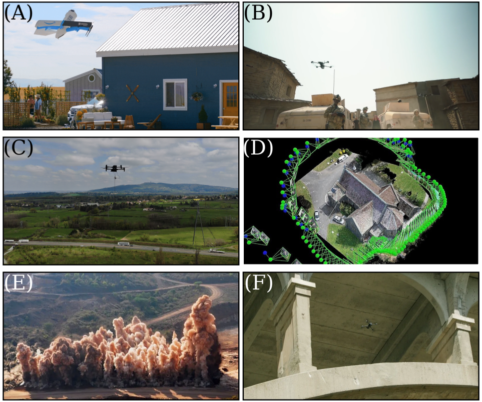


[Martin et al., 2020]
[Watkins et al., 2020]

Example Content Slide

UAVs are becoming increasingly prevalent in urban environments

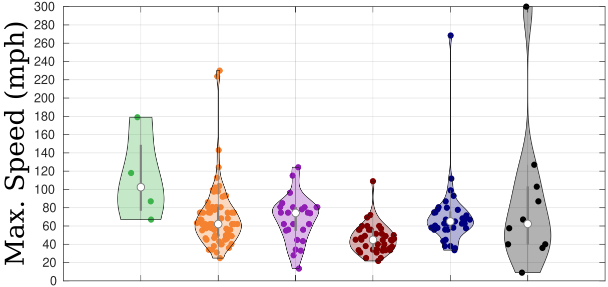
(A) Medical/package delivery
(B) Public safety/ military applications
(C) Traffic monitoring
(D) Photogrammetry
(E) Toxic, flammable, and explosive environments
(F) Urban infrastructure inspection



(A) [Amazon Staff, 2024] (B) [Skydio, 2024]
(C) [Elistair, 2024] (D) [Pix4D, 2018]
(E) [Propeller Aero, 2024] (F) [Netto, 2023]

Example Transition Slide

UNIVERSITY OF NORTH CAROLINA CHARLOTTE



FPV Multirotor

Fixed-wing

Helicopter

Multirotor

Quadplane/Tiltrotor

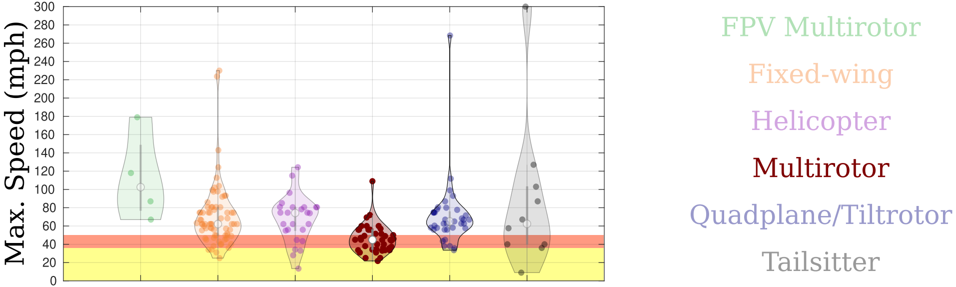
Tailsitter

[Kakavitsas et al., 2024]

	Gust (mph)	Speed (mph)
Mean	22	11.46
Median	21.3	10.8
Max	56.6	38.4

Charlotte, NC wind speed and gust data for 2023-24 [VisualCrossing, 2021]

Example Transition Slide



[Kakavitsas et al., 2024]

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Mean	22	11.46
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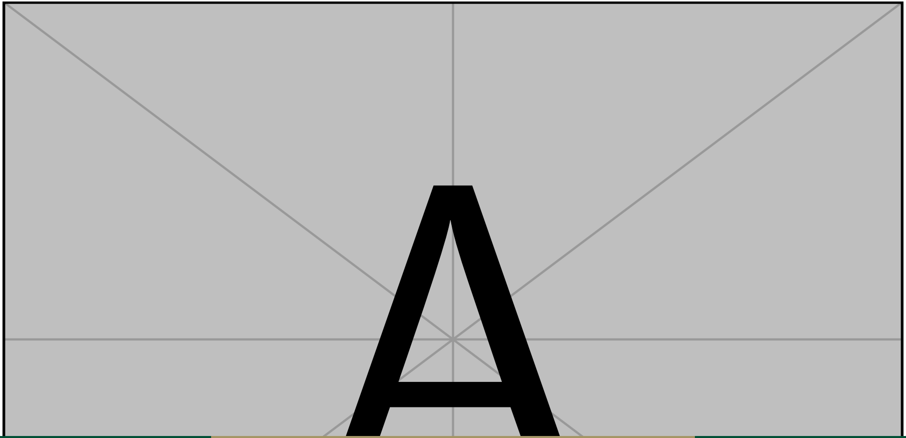
Max	56.6	38.4

Charlotte, NC wind speed and gust data for 2023-24 [VisualCrossing, 2021]

Thesis Statement

Put your sample text here. **Emphasize points** with the commands defined in main.tex

Make a figure that defines all topics of your dissertation and ties in with the thesis statement at the top.



Example Multi-Slide Table and Equations

In this work, we investigate the use of various feature spaces F_i corresponding to respective feature vectors $\boldsymbol{x}_i$.

These feature vectors contain some combination of

- $\boldsymbol{r}$ = Locations of wind samples
- $\rho(\boldsymbol{r}), \nabla\rho(\boldsymbol{r})$ = SDF and gradient samples at $\boldsymbol{r}$
- $\rho(\boldsymbol{r}+\boldsymbol{b}_i), \nabla\rho(\boldsymbol{r}+\boldsymbol{b}_i)$ = SDF and gradient samples at $\boldsymbol{b}_i$ points surrounding $\boldsymbol{r}$

Candidate vectors include:

No.	$\boldsymbol{r}$	$\rho(\boldsymbol{r})$	$\nabla\rho(\boldsymbol{r})$	$\rho(\boldsymbol{r}+\boldsymbol{b}_{i,\ldots,B})$	$\nabla\rho(\boldsymbol{r}+\boldsymbol{b}_{i,\ldots,B})$
F_1	✓				
F_2	✓	✓	✓		
F_3	✓	✓	✓	✓	✓
F_4	✓	✓	✓	✓	
F_5	✓	✓		✓	
F_6	✓	✓			
F_7	✓	✓	✓		✓
F_8	✓		✓		✓

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F_1	✓				
F_2	✓	✓	✓		
F_3	✓	✓	✓	✓	✓
F_4	✓	✓	✓	✓	
F_5	✓	✓		✓	
F_6	✓	✓			
F_7	✓	✓	✓		✓
F_8	✓		✓		✓

Example Multi-Slide Table and Equations

Some kernels that are investigated with different levels of optimization include:

- κ_1 - Grouped squared exponential

$$\kappa_1 = \kappa_{\text{sq}}\left(\boldsymbol{h}, \boldsymbol{\theta}_{\text{sq},\boldsymbol{r}}\right) + \kappa_{\text{sq}}\left(\boldsymbol{h}, \boldsymbol{\theta}_{\text{sq},\rho(\boldsymbol{r}),\nabla\rho(\boldsymbol{r})}\right) + \sum_{i=1}^{R} \kappa_{\text{sq}}\left(\boldsymbol{h}, \boldsymbol{\theta}_{\text{sq},\rho(\boldsymbol{r}+\boldsymbol{b}_i),\nabla\rho(\boldsymbol{r}+\boldsymbol{b}_i)}\right)$$

Candidate vectors include:

No.	$\boldsymbol{r}$	$\rho(\boldsymbol{r})$	$\nabla\rho(\boldsymbol{r})$	$\rho(\boldsymbol{r}+\boldsymbol{b}_{i,\dots,B})$	$\nabla\rho(\boldsymbol{r}+\boldsymbol{b}_{i,\dots,B})$
F_1	✓				
F_2	✓	✓	✓		
F_3	✓	✓	✓	✓	✓
F_4	✓	✓	✓	✓	
F_5	✓	✓		✓	
F_6	✓	✓			
F_7	✓	✓	✓		✓
F_8	✓		✓		✓

Gaussian Process Regression (GPR)
Variational GPR (VGP)

Example Multi-Slide Table and Equations

Some kernels that are investigated with different levels of optimization include:

- κ_1 - Grouped squared exponential
- κ_2 - Standard squared exponential $\times$ coregion kernel [Bonilla et al., 2008, Tipping and Bishop, 1999]

Candidate vectors include:

No.	$\boldsymbol{r}$	$\rho(\boldsymbol{r})$	$\nabla\rho(\boldsymbol{r})$	$\rho(\boldsymbol{r}+\boldsymbol{b}_{i,\ldots,B})$	$\nabla\rho(\boldsymbol{r}+\boldsymbol{b}_{i,\ldots,B})$
F_1	✓				
F_2	✓	✓	✓		
F_3	✓	✓	✓	✓	✓
F_4	✓	✓	✓	✓	
F_5	✓	✓		✓	
F_6	✓	✓			
F_7	✓	✓	✓		✓
F_8	✓		✓		✓

Gaussian Process Regression (GPR)

Variational GPR (VGP)

Example Multi-Slide Table and Equations

Some kernels that are investigated with different levels of optimization include:

- κ_1 - Grouped squared exponential
- κ_2 - Standard squared exponential $\times$ coregion kernel [Bonilla et al., 2008, Tipping and Bishop, 1999]
- κ_3 - Standard squared exponential

$$\kappa_{\text{sq}}(\boldsymbol{h},\ \boldsymbol{\theta}_{\text{sq}}) = \sigma^2 \exp\left(-\frac{1}{2}\sum_{i=1}^{n}\left(\frac{h_i}{L_i}\right)^2\right)$$

Candidate vectors include:

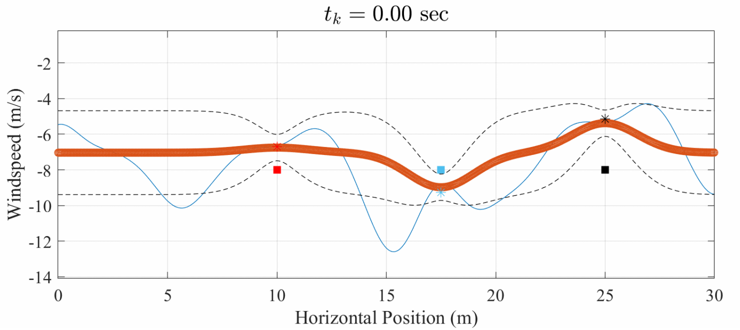
No.	$\boldsymbol{r}$	$\rho(\boldsymbol{r})$	$\nabla\rho(\boldsymbol{r})$	$\rho(\boldsymbol{r}+\boldsymbol{b}_{i,\ldots,B})$	$\nabla\rho(\boldsymbol{r}+\boldsymbol{b}_{i,\ldots,B})$
F_1	✓				
F_2	✓	✓	✓		
F_3	✓	✓	✓	✓	✓
F_4	✓	✓	✓	✓	
F_5	✓	✓		✓	
F_6	✓	✓			
F_7	✓	✓	✓		✓
F_8	✓		✓		✓

Gaussian Process Regression (GPR)

Variational GPR (VGP)

Example Animation

These animations only really work when viewed in Adobe reader. Adobe reader has a presentation mode, and during the presentation, you just use the controls under the animation frame to play the animation.



$$L = 1.5 \text{ m}$$
$$\sigma^2 = 4 \text{ m}^2$$
$$\sigma_n^2 = 0.6 \text{ (m/s)}^2$$
$$\mu_w = -8 \text{ m/s}$$

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Introduction

Introduction appendix slides

UAV Classifications

Table 1: U.S. Department of Defense UAS classifications. [US Department of Defense, 2021].

UAS Group	Maximum take-off weight (lbs) (MTOW)	Nominal operating altitude (ft)	Speed (knots) [mph]
Group 1	0–20	$<$ 1,200 AGL	100 [115]
Group 2	21–55	$<$ 3,500 AGL	$<$ 250 [289]
Group 3	$<$ 1,320	$<$ FL 18,000	$<$ 250 [289]
Group 4	$<$ 1,320	$<$ FL 18,000	Any airspeed
Group 5	$<$ 1,320	$>$ FL 18,000	Any airspeed