



Lecture 15: Final Logistics

You're almost done!

Agenda

- **Rest of Year Schedule**
- SEAS R&D Showcase
- Practice Presentation + Final Presentation
- Final Demo
- Final Package Submission
- Mentor Meetings



Schedule

4/4	Sign up for SEAS R&D Showcase
4/9 (lab)	Practice Presentation
Week of 4/14	Final Demo (code complete)
4/18	SEAS R&D Showcase Poster Submission
4/23 (lab)	Final Presentation
4/25	SEAS R&D Showcase
5/11	Final Package Due

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SEAS R&D Showcase

- Timeline
 - 4/4: [Student application](#) due (one submission per team)
 - 4/18: [Poster submission](#) due (one submission per team)
 - 4/25: R&D Showcase (full agenda: <https://showcase.engineering.gwu.edu/participate>)
- Poster guidelines
 - 36" x 48"
 - Free printing: <https://library.gwu.edu/3-d-and-large-format-printing>
 - Note: print the poster early – may need up to 5 days notice

<https://showcase.engineering.gwu.edu/participate>

Example R&D Showcase Poster



BikeBuddy
Ethan Cohen | Claes Boillot | Matt Gouvin | Adham Popal
The George Washington University
Department of Computer Science



The Problem

Despite having some of the best bicycle infrastructure in North America, Washington still sees cars hitting and killing cyclists at an alarming rate. BikeBuddy aims to route cyclists to their destination along safe, efficient, and reliable routes.

The Algorithm

Our app pulls from OpenStreetMap as well as Open Data DC, an API provided by city government that contains data about cycling infrastructure, road safety, and crime across the District. The red dots in the map to the bottom left show the majority of data points collected.

The Architecture

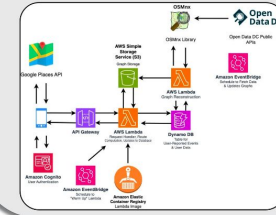
BikeBuddy fundamentally lives in an AWS Lambda function that connects our front and back ends. From the mobile app, users can request routes as well as report unsafe conditions they encounter. An AWS EventBridge scheduler refreshes the data every morning so the map is always up to date. Our graphs and lookup structures are stored in S3.

The Application



We utilize the OSMnx in Python for graph creation, specialized for maps. Construction of graph data structures works by using our ingested data to add specific bike nodes and their attributes to the base graph for D.C. We utilize a cKDTree (plot on the left) for efficient lookup of bike nodes that will be added.

Routing works by modifying the weights of edges of our custom graphs. Thus, the shortest path from the graph's point of view will generate based on the weight modifications we have put in place. This can include user preferences, user reports, and bike attributes from our data ingest.




Department of Computer Science
School of Engineering & Applied Science



Engineering


Example R&D Showcase Poster



THE GEORGE
WASHINGTON
UNIVERSITY
WASHINGTON, DC

RTX CAPSTONE COMPETITION

MAE: BRENDAN HUMPHREY, IFTAKHAR ALAM, NITHA PAULUS, RYAN RAFATI
CS (UAV): KARL SIMON, LEO PHAN, JUSTIN PARK
CS (UGV): MANUE ALAIMO, DANIA ABDALLA, KAYLA BERNE
ADVISORS: JARICK CAMMARATO, STEVEN SHOOTER, TIMOTHY WOOD



SEAS

Motivation

- The drone competition integrates advanced tech like AI, vision, autonomy, and 3D printing. This year's "Water Blast" mission pushes the boundaries of unmanned vehicle technology
- Real-World Applications: By solving the "Water Blast" challenge, teams contribute to the development of drone tech for tasks like package delivery and firefighting
- The competition is a high-energy event where months of hard work culminate in showcasing creations and competing against other top teams.

Objective

- Engage students in the RTX drone competition, comprising seeker and evader challenges
- Develop algorithms for UAV navigation and object detection to meet competition requirements
- Design, prototype, and optimize water deployment and detection systems for UAVs and UGVs
- Execute precise coordination and strategic decision-making to overcome competition challenges
- Enhance students' understanding of engineering principles through hands-on application and experiential learning

Overall Approach

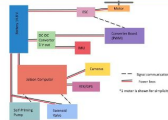


Figure 1: UAV Circuit Architecture

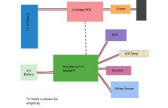


Figure 2: UGV Circuit Architecture

Implementation of Approach

Unmanned Aerial Vehicle (UAV)

- UAV is a hexacopter (6 propellers)
- Nvidia Jetson Orin Nano for image processing and route planning
- Flight controller equipped with three IMU sensors and a barometer
- 14.8 V 4000 mAh battery to power all UAV systems, capable of ~12 minutes flight time
- Camera – Full HD, 60 fps, 128° FOV – for ArUco marker detection
- GPS receiver for navigation
- Range finder for altitude measurement
- RF receiver for remote control

Water Deployment System

- Self-priming pump delivers a consistent flow rate of 8mL/second at 12v, controlled by a normally closed solenoid valve connected to the onboard computer.
- Adjustable nozzle optimizes spray pattern, while quick-connect tubing allows for fast assembly, disassembly, and future modifications.
- Custom-designed 3D-printed structures (ABS plastic) provide secure and reliable component placement on the drone frame

Unmanned Ground Vehicle (UGV)

- Basic frame with patterned holes for variable mounting
- 2 motor drive with 0.69 Nm, 294 RPM motors powered by a 7.4 V 5200 mAh battery
- Raspberry Pi 4 Model B powered by a separate 5 V battery
- ROS workspace with nodes and topics to facilitate communication between all sensors and the Pi

Water Detection System

- Hydrophobic-coated ArUco marker placed on an angled (3.5 degrees) funnel allows water to flow seamlessly into the funnel while remaining easily detectable by the sensor
- The water detection chip, angled to prevent water build-up, triggers a dual response upon water contact. First, a signal alerts the team of water detection, and second, LED lights and an alarm on the UGV visually confirm the detection

Current Design




Figure 3: Full CAD Assembly




Figure 4: Photographs of current assembly

Algorithms and Testing

UAV

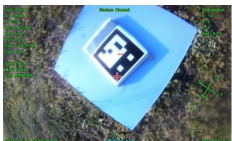


Figure 5: Camera footage from camera on UAV

- We tested our UAV at GW VSTC and UMD campus, outside DC light restricted zone
- Users can view real-time camera footage and sensor readings from the UAV
- The UAV can be controlled remotely via remote controllers and computers
- The UAV flies autonomously 3 meters in the air to scan for ArUco Markers
- Once detected a non-ally marker, the UAV flies toward it and releases water
- When all non-ally markers have been targeted, the UAV flies back to its base

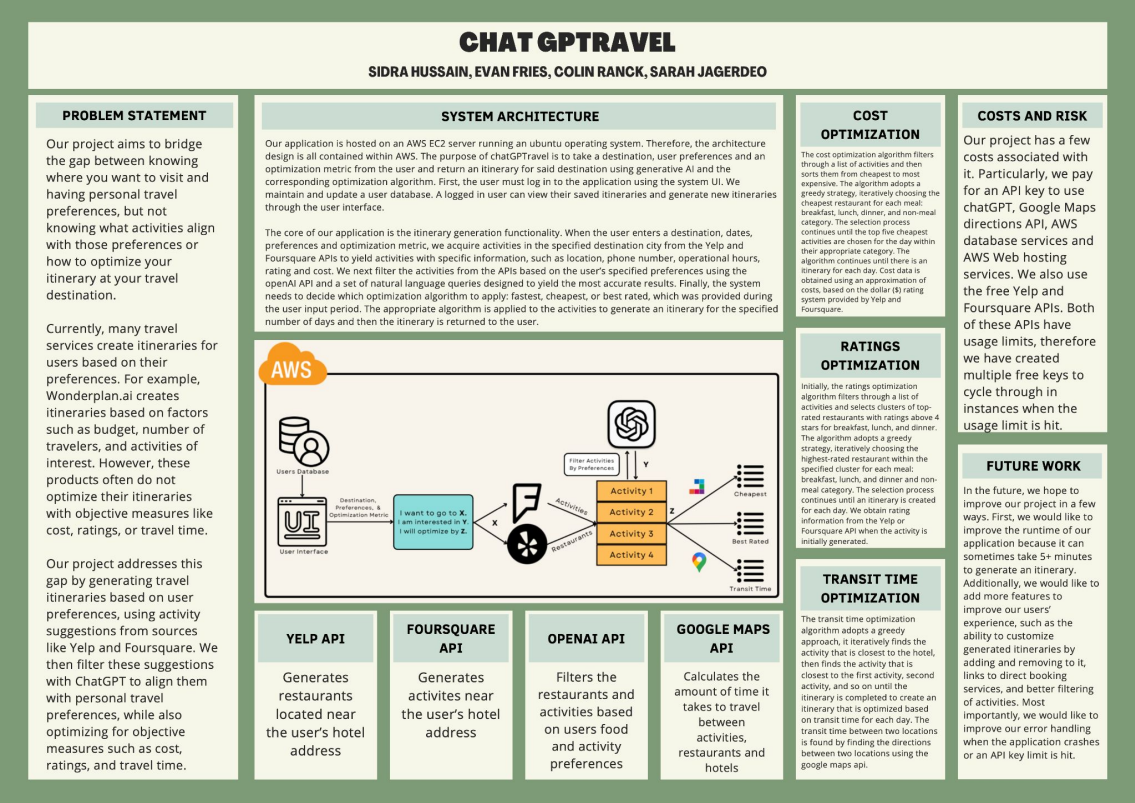
UGV

- We tested our UGV following each of the challenges
- Motor controls UGV at 3 constant speeds
- When UGV has been hit, alerts with lights and buzzer and logs the hit with time
- When hit UGV will immediately disable the motors and the UGV will stop traveling
- UGV uses on board IMU sensor to make precise 90 degree turns and stay on a straight linear path

Acknowledgments

Special thanks to Jarick Cammarato, Professor Steven Shooter, Professor Timothy Wood, the GW 3D Printing Lab, the GW Machine Shop, & the Drone Lab

Example R&D Showcase Poster



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Practice Presentation (4/7)

- Logistics

- 7-8 minutes long
- Very similar to presentation 3 – use slides as a starting point
- Everyone should be in-person
- Everyone should stay for the full duration (will likely run past 8pm, reschedule mentor meetings if needed)
- Upload slides [here](#)

- Goals

- Describe the problem & motivate the project
- Show an overview of the technical components
- Explain the full scope of the project
- Include a comprehensive demo to illustrate your work (can be pre-recorded)

Presentation Template (similar to presentation 3)

≡

INTRO

Problem to be solved

- Key Concepts from Writing 1

Users

- User Personas: 1-2 key users max

Impact

- How is this different from other apps?

TECH

Implementation

- Technical Designs: Diagrams, Algorithms, APIs, etc.
- If using Diagram, use a shortened version with the fewest components max (*No more than 5 is recommended*)

Algorithmic Components

- Explain the algorithmic complexity

DEMO

Final Deliverable

- Describe all implemented functionality
- Recorded demo or screenshots (brief demo ~ 1-2 min)
- Can be a small portion of the presentation or interspersed throughout

Final Presentation (4/23)

- Same as practice presentation, refined based on instructor feedback
- Will be held in Lehman Auditorium



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Final Demo (Week of 4/14)

- Logistics
 - Signup for a demo slot [here](#) ; reach out ASAP if none of those times work
 - Demo will be over Zoom
- Pre-read Submissions
 - 48 hours before your demo, you must share a team pre-read with instructors (send it over slack)
 - Each team member must prepare at least one slide highlighting their top contributions throughout the year, including github links to key code
 - These contributions should describe what was done technically, as well as how the work ties back to the project as a whole
- Expectations
 - Show end to end working system (can be recorded)
 - Present the complete project, not just the work done after Demo 4
 - Each individual should showcase their main contributions, which do not necessarily need to be the most recent work
 - Come prepared to make efficient use of the time – 30 minutes is not a lot!

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Final Package Submission (5/11)

- Team Website (update to include the following)
 - Project description
 - Bio of team members
 - Writing 4 (from the fall semester)
 - Final presentation slides (PDF)
 - SEAS R&D Showcase poster (PDF)
 - Link to GitHub repo(s) with all code
- Google Drive (upload the following to your team folder [here](#))
 - README.md including project description + link to team website
 - Writing 4
 - Final presentation slides (PDF)
 - SEAS R&D Showcase poster (PDF)
 - Zipfile of GitHub repo(s) with all code

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Mentor Meetings

- Please practice your demos & presentations with your mentors and ask them to review your slides
- Your last required meeting with your mentor is next week (4/7), but feel free to coordinate with them if you want to meet the week of 4/14
- We've invited your mentors to your final presentations (in-person or over zoom) so they can see all the great progress you all have made!