Introduction to ScooterLab

ScooterLab Workshop 2026

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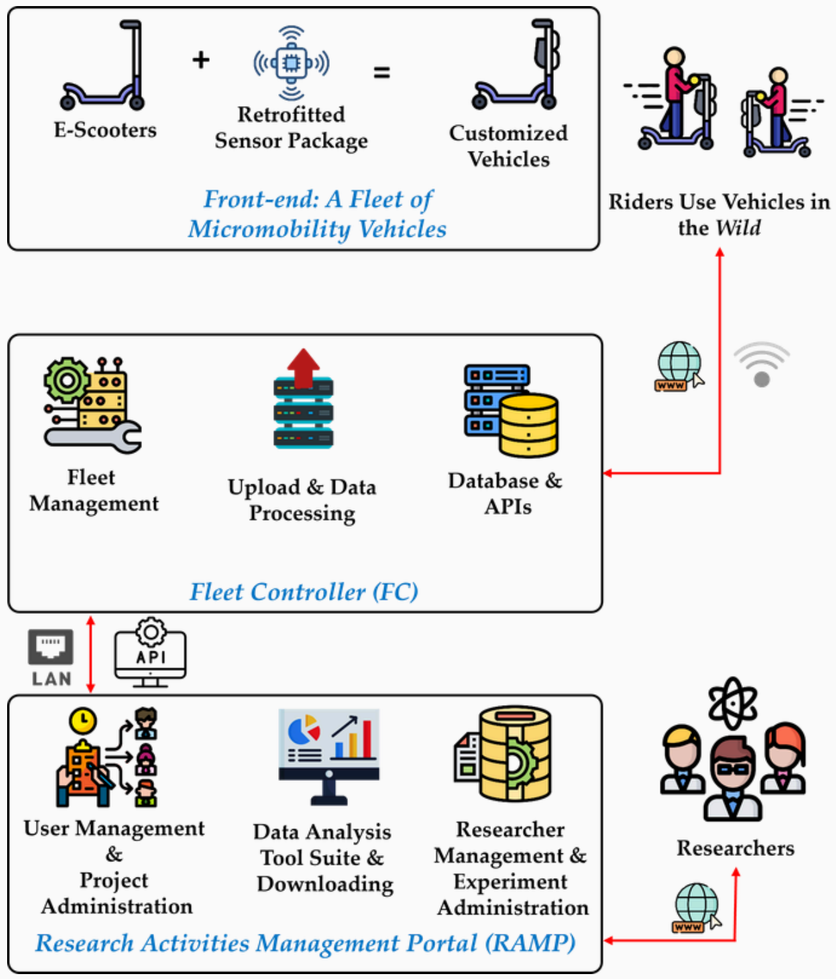
At a Glance

Overview

A community research testbed providing a programmable and participatory micromobility-supported sensing platform

Advance research at the intersection of Computer and Information Science and Engineering and interdisciplinary domains such as urban planning, mobility analytics, privacy and security, environmental sensing, and smart city infrastructure.



Architecture

Front-end: E-scooters & sensing

Fleet of e-scooters retrofitted with onboard sensor packages for continuous data collection during real-world rides.

Fleet Controller

Operational backbone manages the fleet, ingests sensor data from scooters, preprocesses and de-identifies streams, and integrates external context.

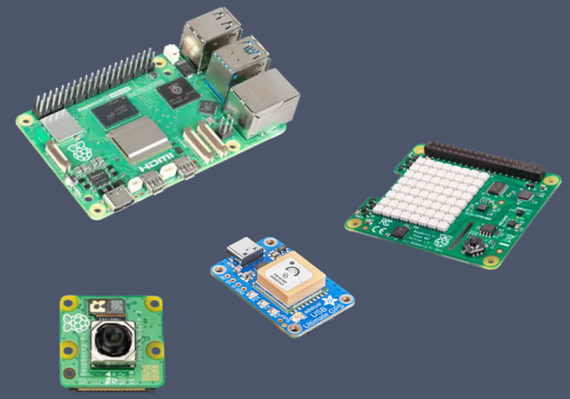
Research Activities Management Portal (RAMP)

Web interface for the research community. Researchers request projects, manage experiments, and access curated data through built-in visualization and analysis tools.

Vehicle & Sensing Design Goals

Source E-Scooters

Procure commercially available e-scooters suitable for retrofitting.



Develop a Sensor Suite

Design and engineer a custom sensor package to collect mobility, environmental, and contextual data.

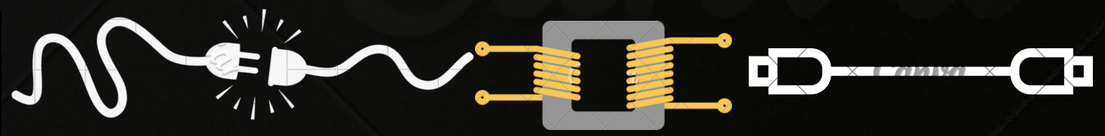
Retrofit & Integrate

Attach the sensor suite to e-scooters to create programmable research vehicles.

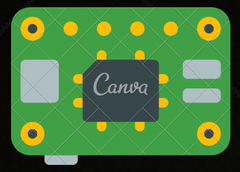
Sensor Suite

Wireless Base-station Computer (WBSC)

42V E-Scooter Battery

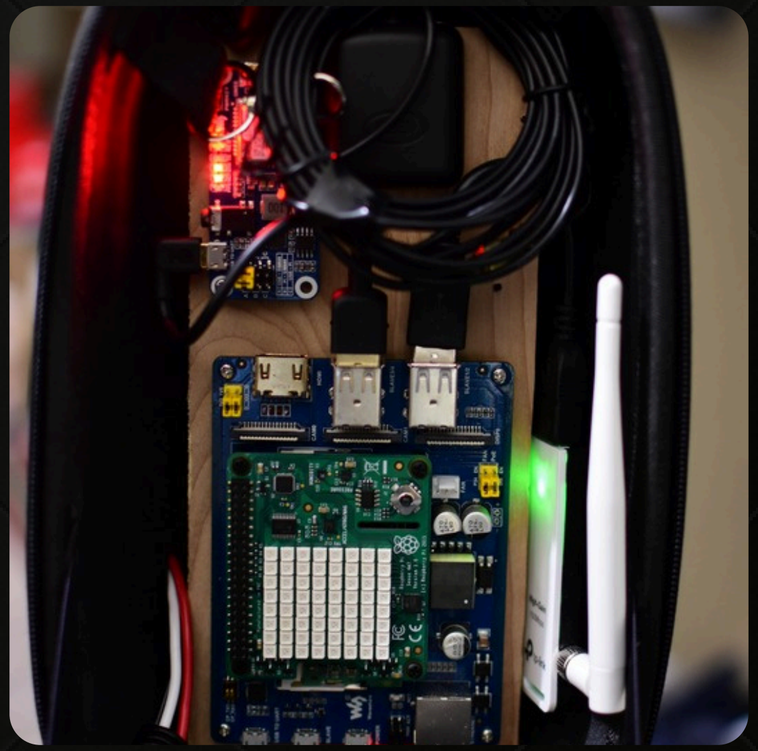


Step-down Transformer 42V → 5V



Single Board Computer

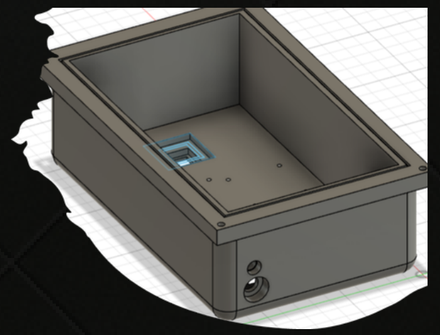
Initial Prototypes

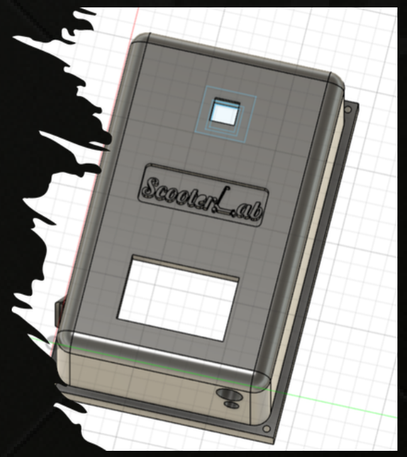


WBSC Enclosure

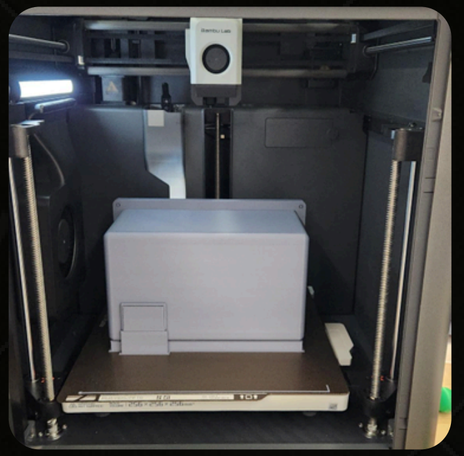
In-House Modeling

- Modeled for modularity and weather protection
- Custom fit for scooter stem dimensions
- Easily replaceable and upgradable





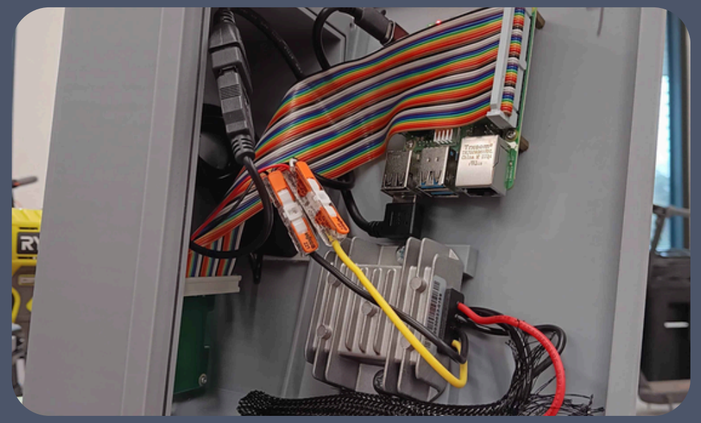
3D Printed In-House



Deployed Setup

E-Scooter

- Segway Ninebot G30P MAX
- 18.6mph max speed
- 40-mile range



Wireless Base-station Computer

- Raspberry Pi 5, SenseHAT v2
- Sensors: Light, Temperature, Pressure, Humidity, Accelerometer, Gyroscope, Orientation, Magnetometer
- GPS, Bluetooth, WiFi
- Camera, Microphone

Sensor Service

1. Create and edit the `startsensor.service` file:

```
sudo nano /etc/systemd/system/startsensor.service
```

2. Start the `startsensor.service`:

```
sudo systemctl start startsensor.service
```

3. Stop the `startsensor.service`:

```
sudo systemctl stop startsensor.service
```

Software

- Configurable per-sensor sampling rates
- BLE connection to E-Scooter firmware
- Data upload to backend server (FC).

Operations

- Riders onboard through a structured five-step process, with all steps now available through the ScooterLab mobile app.
- An IRB was approved for the base-experiment.
- Future experiments may either require modifications or new IRBs based on the experiment criteria.

1. Participant Onboarding

In-person check-out appointment at a designated campus location.

2. Consent, Terms & Conditions

IRB-approved consent form covering usage terms, data collection, and rider responsibilities.

3. Safety Video

Mandatory video covering safe e-scooter operation before first ride.

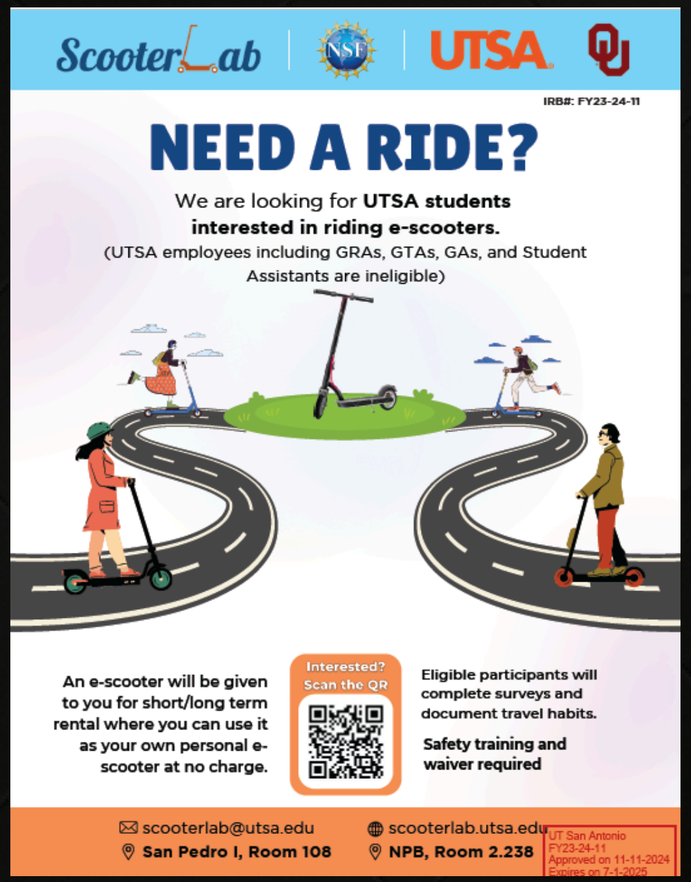
4. Travel Survey

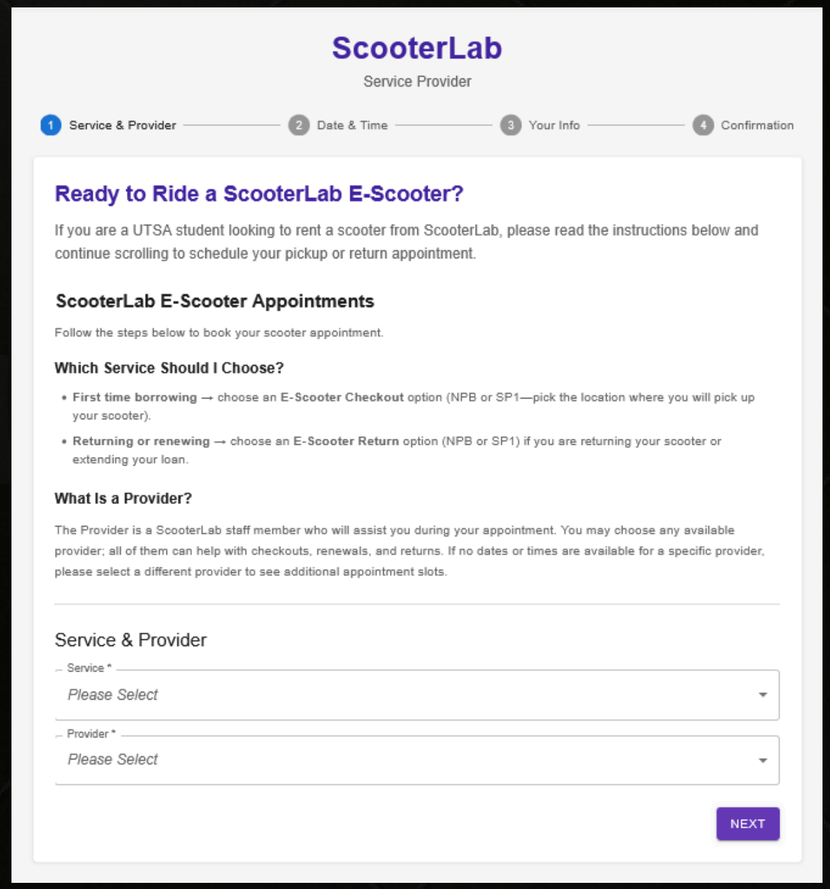
Demographic and travel-behavior survey capturing rider context over the prior 14 days.

4. Return/Renew

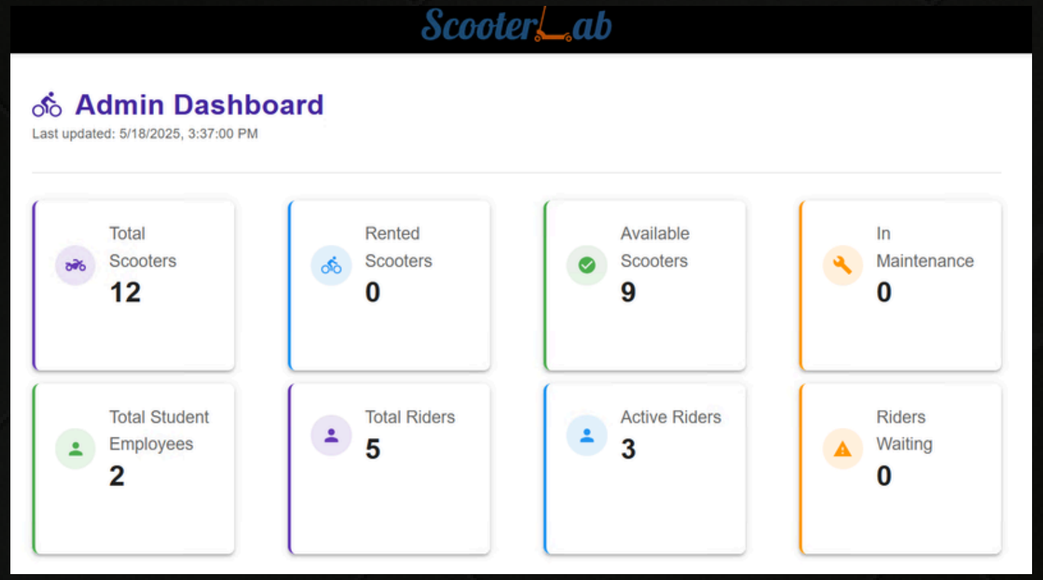
Participants either return the e-scooter or renew it for another 14-days.

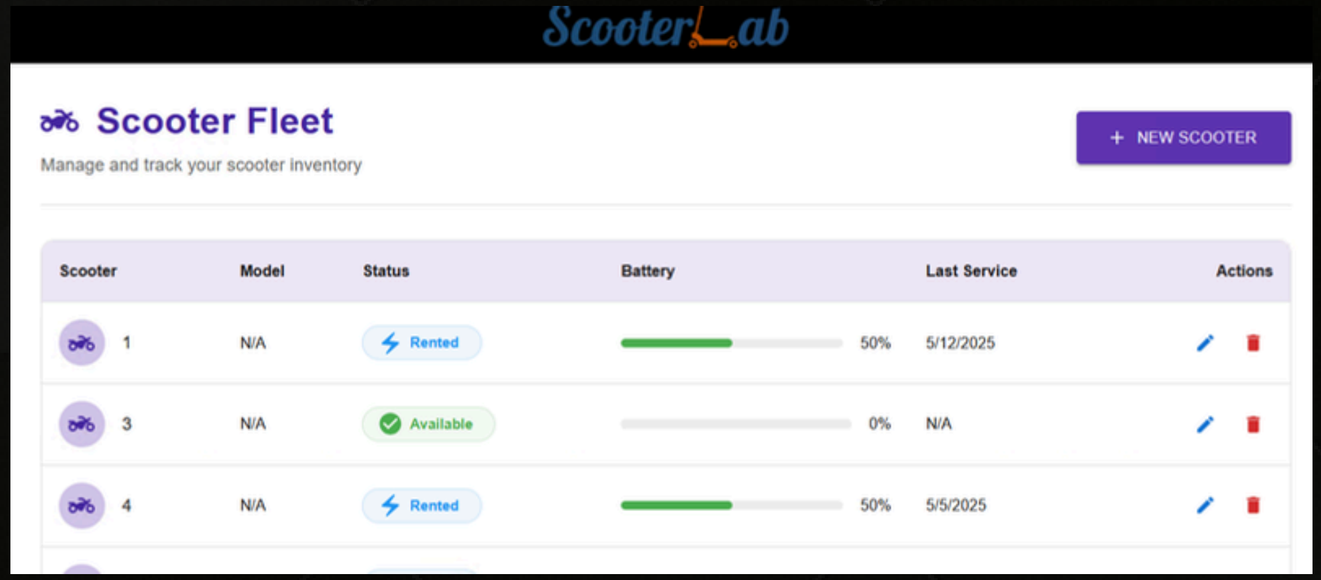
Recruitment



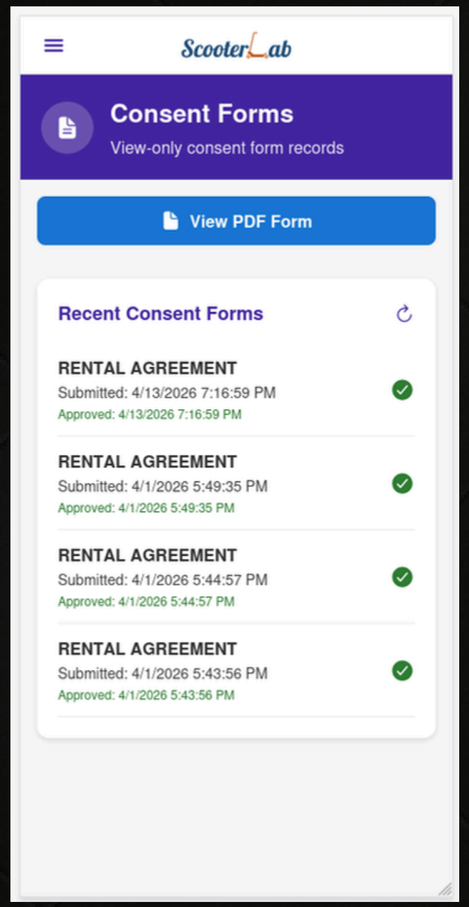


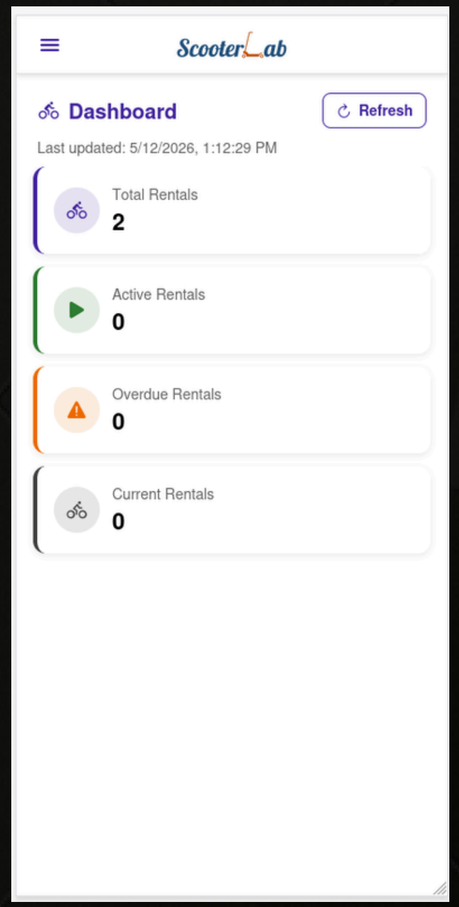
Fleet Management

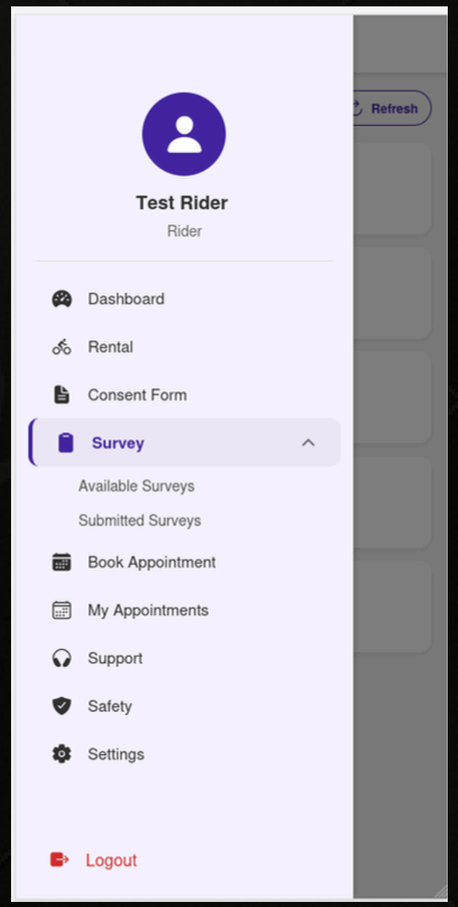


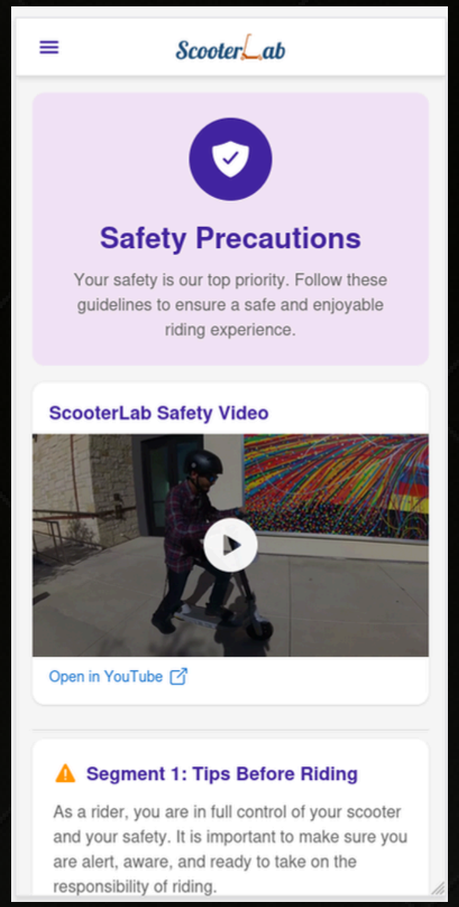


Participant (Rider) Mobile App









Stats So Far

Total Trips: ~ 1500

Total Miles: ~ 2300 mi

Collaborator-Driven Experiments

Georgia Tech

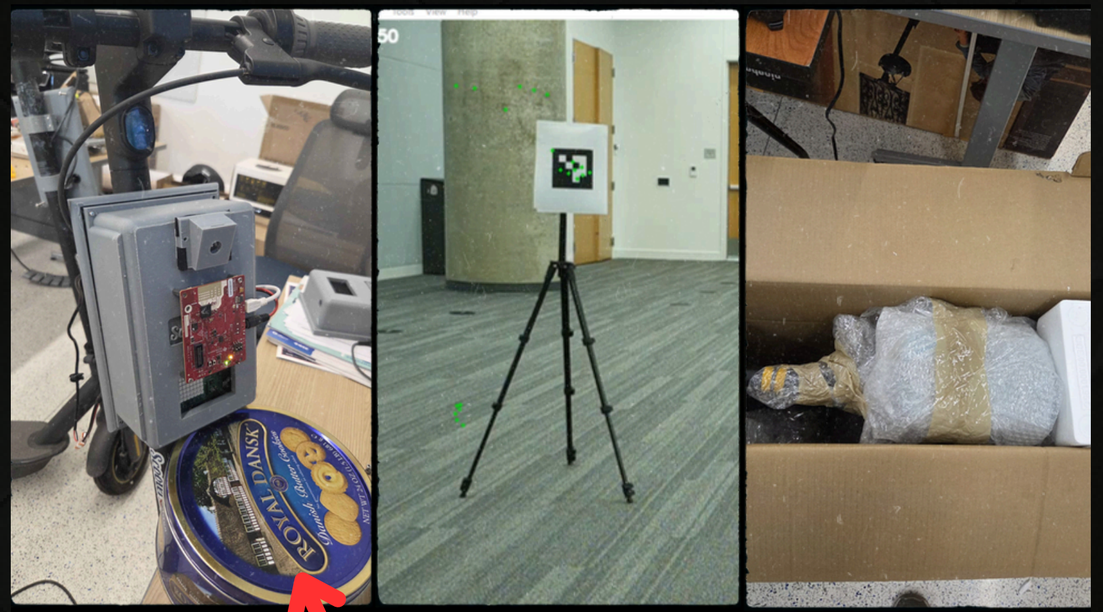
UTSA Urban and Regional Planning

Texas A&M Transportation Institute

MIAMI UNIVERSITY

- Research collaborations spanning environmental sensing, accessibility and micromobility safety.
- Several of these collaborations requested new sensor integrations on the testbed.

mmWave Radar for MyPath

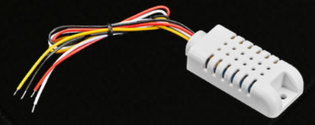


Our lab sewing kit...

- The MyPath team at Miami University requested ScooterLab to integrate mmWave radar
- MyPath studies accessible routing by mapping sidewalk and path conditions for wheelchair and mobility-impaired users.
- Texas Instruments AWR1843BOOST
- We integrated the sensor into the WBSC, tested it, and shipped the e-scooter to Ohio.

Temperature & Air Quality for Heat and AQ Research

- Teams from Georgia Tech and UT San Antonio Urban & Regional Planning
- SHT-30 (temperature, humidity) and Adafruit/Plantower Adafruit PMSA003I air quality sensor into the WBSC
- Working with collaborators: calibration trials against reference instruments; Kestrel weather meters and PurpleAir



LiDAR for Urban Sensing

- In collaboration with a team from UT San Antonio Urban and Regional Planning
- GPS integration with Ouster LiDAR
- Supporting mobile LiDAR data collection workflows
- Comparing high-end Ouster LiDAR with lower-cost sensing options such as LD19

Out There with LiDAR

- Scooter-mounted LD19 alongside Ouster ground truth for crowd monitoring

- Field trials
  - walking
  - scooter LiDAR vs Ouster
  - vehicle-mounted

And during one of those downtown drives...

And during one of those downtown drives...

Waymo

Us

What’s Next?
A Distributed Sensing Platform

From a single testbed to a global sensing network

Publish the hardware and sensor box software; 3D models, BOM, assembly/integration guides.

Assemble your own sensor box

Researchers anywhere; Tokyo, Sydney, Berlin can assemble their own sensor box, mount it on micromobility vehicles they own (e-scooter, e-bike etc.)

ScooterLab as the central data hub

ScooterLab becomes the coordination and data hub. The community gets a multi-city, multi-context dataset no single lab could build alone.

Short-term Road Map

Continue to Support Collaborators

Work with current and new collaborators to conduct their experiments on the testbed

Increase the Fleet

Expand the active fleet and streamline operations

Open the Platform

Publish hardware designs, BOM, and integration documentation. First step toward the distributed network vision

Coming Up Next:

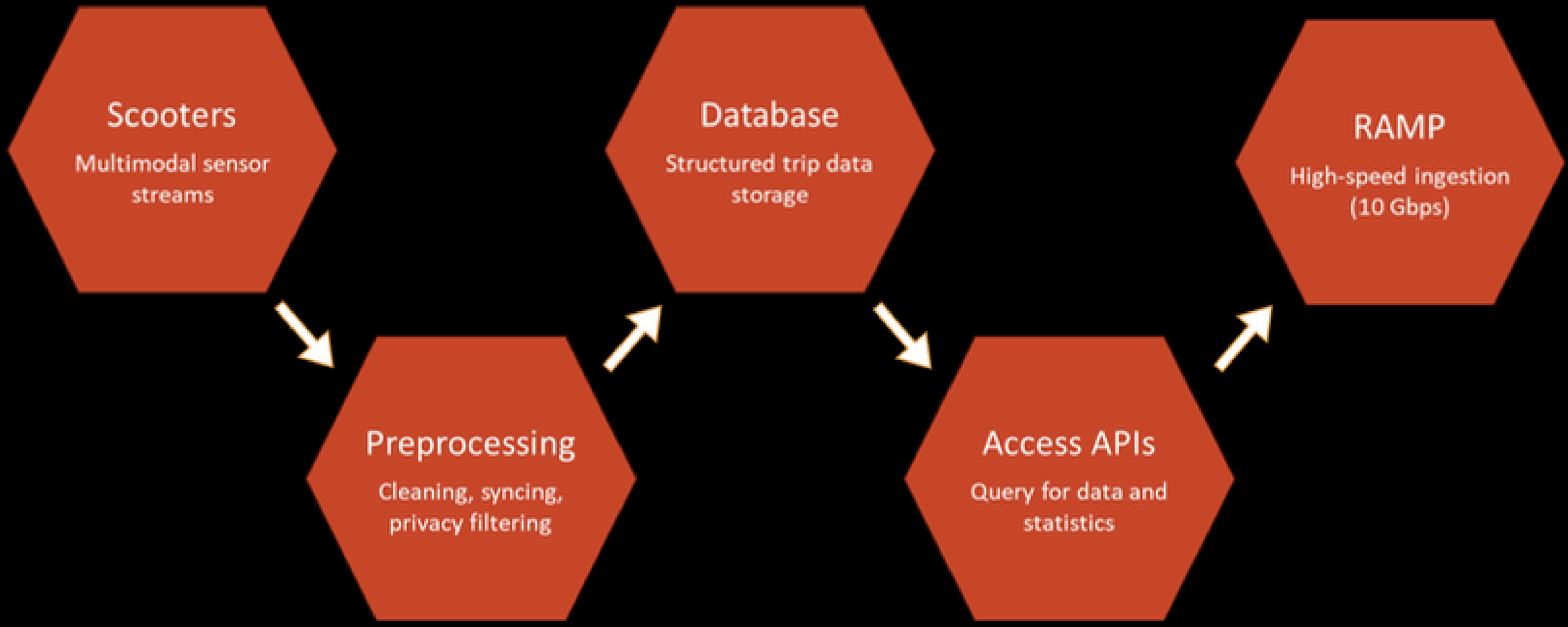
Fleet Controller

Fleet Controller

ScooterLab Workshop 2026

Anindya Maiti
Assistant Professor, University of Oklahoma

Fleet Controller – System Architecture



Fleet Controller – Infrastructure

- Dual Intel Xeon 12-core CPUs
- 512 GB RAM
- 720 TB storage
- 10 Gbps LAN for FC–RAMP communication

Fleet Controller Data (Pre)Processing

Cleaning and Syncing

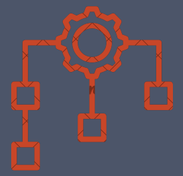
- Remove noisy sensor readings
- Align timestamps from modalities

Privacy Filtering

- Sensitive data blurring:
  - Face
  - House number
  - License plate

Trip Reconstruction

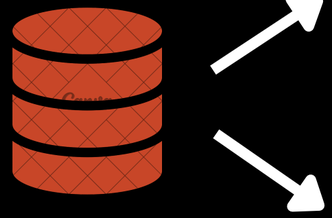
- Segmented data pieced into continuous trips



Structured Output

- Filtered trip/scooter data
- Trip/scooter data statistics

Fleet Controller - Database Storage



Trip

- Video and Audio metadata
- Lidar and mmwave metadata
- Distance and Timing
- Speed statistics

scooter ID

Scooter

- Raw timestep readings
- IMU (Accelerometer, Gyroscope, Yaw, Pitch, etc.)
- GPS (Speed, Longitude, Latitude, Altitude)
- Environment (Temperature, Pressure, Humidity, Lux, etc.)
- Battery

Optimizations

- Database Indexing
  - Scooter ID
  - Trip ID
- Repeated query caching
- Production and Testing Pipelines
  - No downtime

Fleet Controller - System Scale & Integration

~10

Sensors

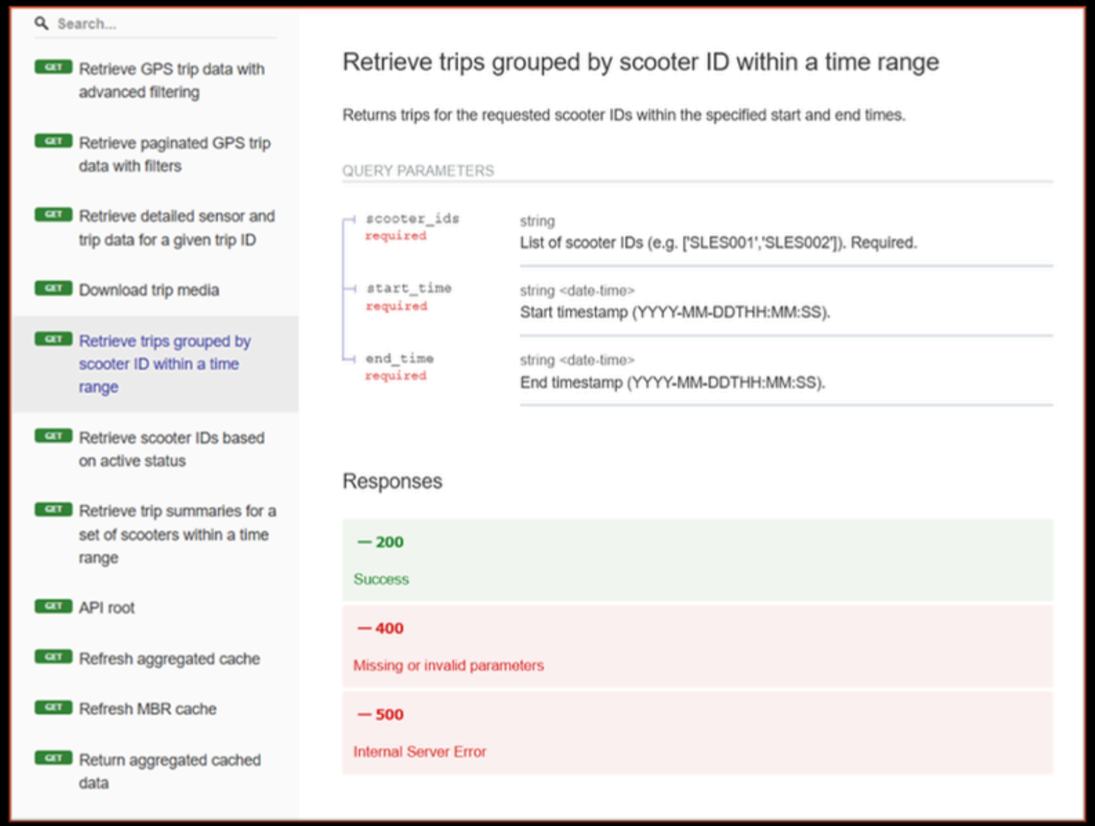
~1500

Trips Logged

~1.4TB

Data

Comprehensive API Documentation



Coming Up Next:

Research Activities Management Portal (RAMP)