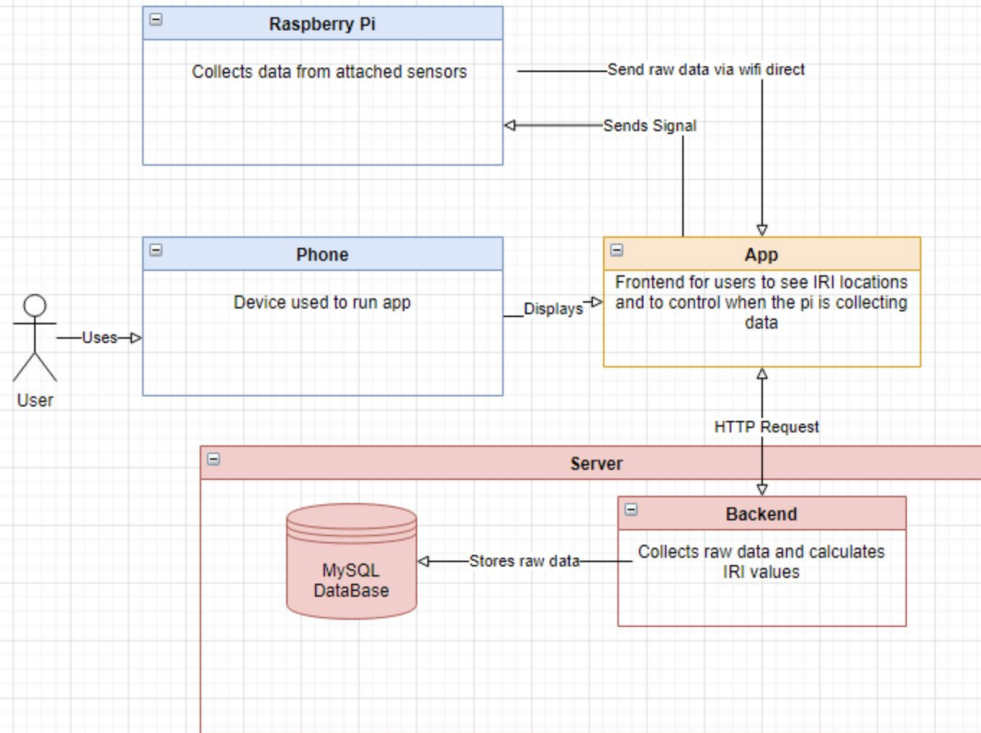# Wensheng Smartbox

Problem Being Addressed

- ❖ Pavement roughness leads to
  - ➢ Driver dissatisfaction
  - ➢ Increase in fuel consumption, emission levels
  - ➢ Unsafe driving conditions
- ❖ Previous methods are expensive
  - ➢ Sensors on bumpers/suspension

Toughbook

GPS

Control box with processor and sensors

Camera

Laser sensor

Overall Design

Software Development Practices & Tools

- ❖ Management
  - ➢ Git/Git Issues
  - ➢ Discord
- ❖ App
  - ➢ Flutter with Android Studio
- ❖ Server
  - ➢ Spring Boot (Java) and SQL database for data and calculation server
  - ➢ JUnit and Mockito for testing
  - ➢ Python
- ❖ Smartbox
  - ➢ Python
  - ➢ Raspberry Pi
  - ➢ GPS Sensor
  - ➢ Accelerometer
  - ➢ Flask Application
  - ➢ Bash Scripts
    - ■ Startup Script
    - ■ Install Script

Server

coms-402-sd-13.cs.iastate.edu:8080/upload/uploadAndCalculate

POST ▾	coms-402-sd-13.cs.iastate.edu:8080/upload/uploadAndCalculate

Params   Authorization   Headers (10)   **Body** ●   Pre-request Script   Tests   Settings

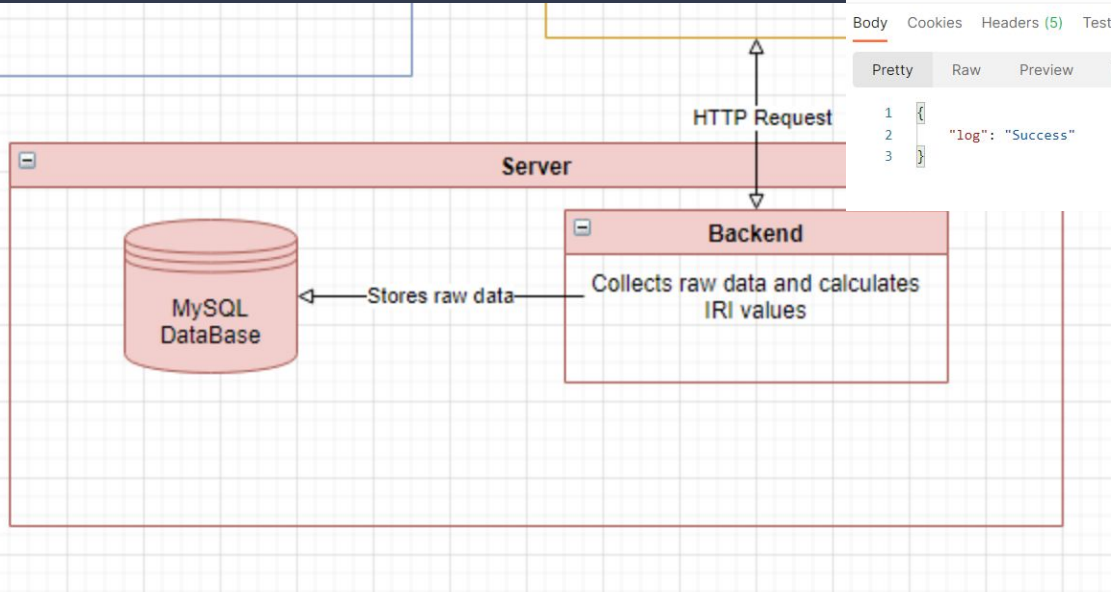⚪ none   🔴 form-data   ⚪ x-www-form-urlencoded   ⚪ raw   ⚪ binary   ⚪ GraphQL

	KEY	VALUE	DESCRIPTION
☑	file	RAW-Car-100Hz-2021-07-06-18-05-02-172-duplicat... ✕	
	Key	Value	Description

Body   Cookies   Headers (5)   Test Results   🌐 Status: **200 OK**   Tin

Pretty   Raw   Preview   Visualize   JSON ▾   ⟲

```
1  {
2      "log": "Success"
3  }
```


Server

HTTP Request

Backend

Collects raw data and calculates
IRI values

MySQL
DataBase ← Stores raw data ←

Server

Calculating

POST ⌄ coms-402-sd-13.cs.iastate.edu:8080/scripts/calculateIRIbyFileName

Params Authorization Headers (9) Body ● Pre-request Script Tests Settings

○ none ○ form-data ○ x-www-form-urlencoded ● raw ○ binary ○ GraphQL JSON ⌄

```
1  {
2      "name": "RAW-Car-100Hz-2021-07-06-18-05-02-172.csv",
3      "hertz":100
4  }
```

Body Cookies Headers (5) Test Results   🌐 Status: 200 OK

Pretty Raw Preview Visualize JSON ⌄

```
1  {
2      "log": "Success"
3  }
```

Body Cookies Headers (5) Test Results   🌐 Status: 417 Expectation Failed Time: 3.27 s Size: 431 B Save Response
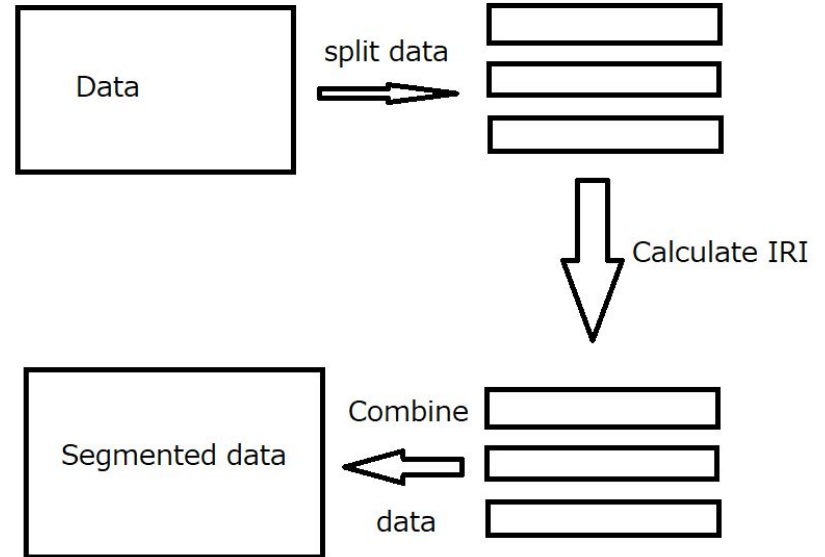
Pretty Raw Preview Visualize JSON ⌄ ⇥

```
1  {
2      "log": "NumberFormatException occurred. Most likely an error on python file. Exception contents:For input string: \"Error! Could not open   Sampleing
          Freqency  file ! Path location provided: /target/algorithm/SD_team/libDb_BlackBox/dbSampFre/10.txt\""
3  }
```

Body Cookies Headers (5) Test Results   🌐 Status: 417 Expectation Failed Time: 90 ms Size: 353 B Save Response

Pretty Raw Preview Visualize JSON ⌄ ⇥

```
1  {
2      "log": "IOException on filename occurred. Check if filename exists. Exception contents:/target/uploads/RAW-Car-100Hz-2021-07-06-18-05-02-12.csv (No
          such file or directory)"
3  }
```

Server

Flow of calculating data

Server

        "name": "RAW-Car-100Hz-2021-07-06-18-05-02-172.csv"
    },
    {
        "id": 521,
        "name": "RAW-Car-100Hz-2021-07-06-18-05-02-172.csv"
    },
    {
        "id": 846,
        "name": "test5.csv"
    },
    {
        "id": 1171,
   "name": "2021-12-08-12:21:52_365297.csv"
    }
]

Example JSON created by the server

{
    "name": "2021-12-08-18:24:31_282589.csv",
    "avgIRI": 53.236,
    "avgMPH": 55.4245,
    "min": 36.9912,
    "max": 61.4222,
    "distance": 1.28942,
    "time": 77.9688,
    "segments": [
        {
            "IRI": 55.7849,
            "avg": 60.3932,
            "distance": 0.100092,
            "time": 5.96094,
            "gps": [
                {
                    "latitude": 42.018,
                    "longitude": -93.7109
                },
                {
                    "latitude": 42.0179,

Smart Box (Data Collection)

- ❖ Configuration of Raspberry Pi
  - ➢ Sensors
  - ➢ Connection
- ❖ Data Collection Script
  - ➢ Setup
  - ➢ Adjustments
  - ➢ Data collection
  - ➢ Storage

Timestamp	Latitude	Longitude	Speed(km/hr)	Acc_X(m/s^2)	Acc_Y(m/s^2)	Acc_Z(m/s^	Gyro_X	Gyro_Y	Gyro_Z
2021-12-08-18-05-02-1	42.01797907	-93.71088925	96.01096257	9.299951172	0.109759521	-1.297076	0.075717	-0.13601	0.2324245
2021-12-08-18-05-02-2	42.01797907	-93.71088925	96.01096257	9.232510376	0.02901001	-1.172214	0.086761	-0.15463	0.2063348
2021-12-08-18-05-02-2	42.01797907	-93.71088925	96.01096257	9.438720703	-0.178994751	-1.914661	0.299384	-0.0708	0.1477604

Smart Box
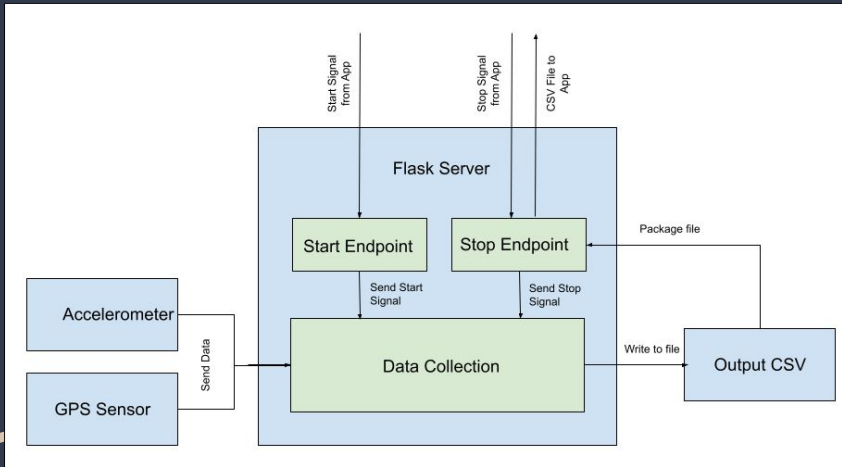
❖ Physical Device
  ➢ Raspberry Pi 4
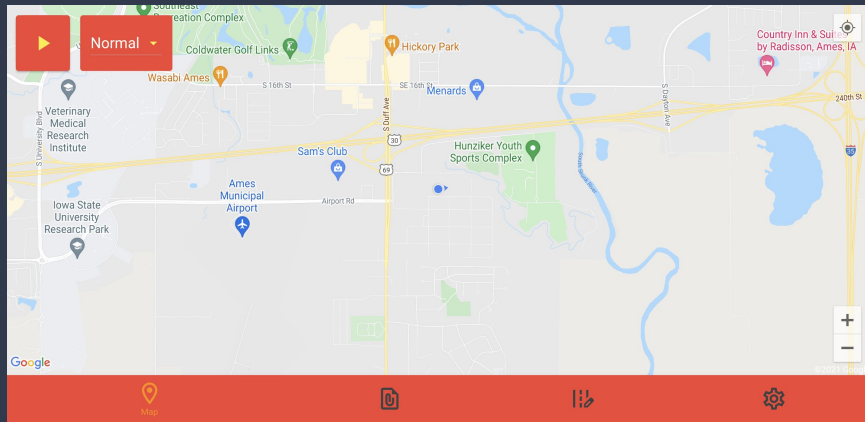 ➢ GPS Sensor
  ➢ Accelerometer

❖ Flask App
  ➢ Allows for the App to start and stop Data collection
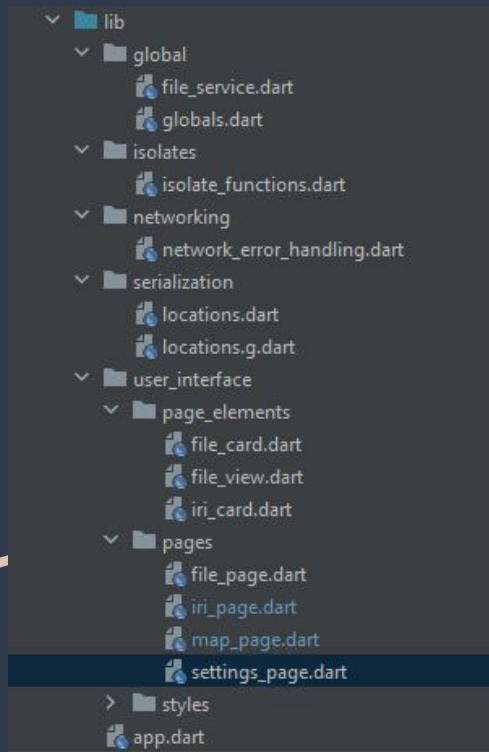 ➢ On halting of data collection sends the file to the app

❖ Initial Setup
  ➢ Setup script to do the following:
    ■ Configure the Pi as an access point
    ■ Install dependencies

App

❖ Acts as the middleman between the smart box and the server
  ➢ Connects to Ad-Hoc WiFi network on smart box
  ➢ Connects through normal internet to server
❖ Commands the smart box to start and stop data collection
❖ Header support to send extra data to smart box and server
  ➢ Vehicle type and device information for server
  ➢ Collection interval arguments for smart box
❖ Displays IRI data on Google Map
  ➢ Color scale to easily distinguish between good and bad values

App Continued

```
∨ ▣ lib
  ∨ 📁 global
      📄 file_service.dart
      📄 globals.dart
  ∨ 📁 isolates
      📄 isolate_functions.dart
  ∨ 📁 networking
      📄 network_error_handling.dart
  ∨ 📁 serialization
      📄 locations.dart
      📄 locations.g.dart
  ∨ 📁 user_interface
    ∨ 📁 page_elements
        📄 file_card.dart
        📄 file_view.dart
        📄 iri_card.dart
    ∨ 📁 pages
        📄 file_page.dart
        📄 iri_page.dart
        📄 map_page.dart
        📄 settings_page.dart
    > 📁 styles
    📄 app.dart
```

❖ Supports viewing of CSV files, deletion of downloaded CSV and JSON files

❖ Renaming of CSV files

❖ Shared preferences support for persistent data
  ➢ IP addresses, vehicle type, etc.

❖ Multiple map types

❖ Displaying of network exceptions to the user

❖ Pull to refresh for dynamic updating of content

Demo

Design Challenges

- ❖ IRI:
  - ➢ International Roughness Index
  - ➢ Way of categorizing road conditions
- ❖ Smart Box:
  - ➢ Modularity
- ❖ Spring Boot/ MySQL handling data:
  - ➢ Wanted algorithm in Python, Java->Python ->Java
  - ➢ Client wanted our stuff compatible with their algorithm
  - ➢ Errors on server
- ❖ Flutter implementation on Frontend:
  - ➢ Can run out of memory trying to parse large datasets
  - ➢ Multithreading - asynchronous
  - ➢ Bluetooth struggles
  - ➢ Writing own mock server

Limitations of Design

- ❖ Smart box
  - ➢ GPS
  - ➢ Hardware
- ❖ Server
  - ➢ Rigid code
  - ➢ Bottleneck on hardware
  - ➢ SQL has very little relationships
  - ➢ Transactional methods
- ❖ Application
  - ➢ Multithreading (threads in Dart are isolated by design)
  - ➢ Knowledge of Flutter was non-existent before the start of semester

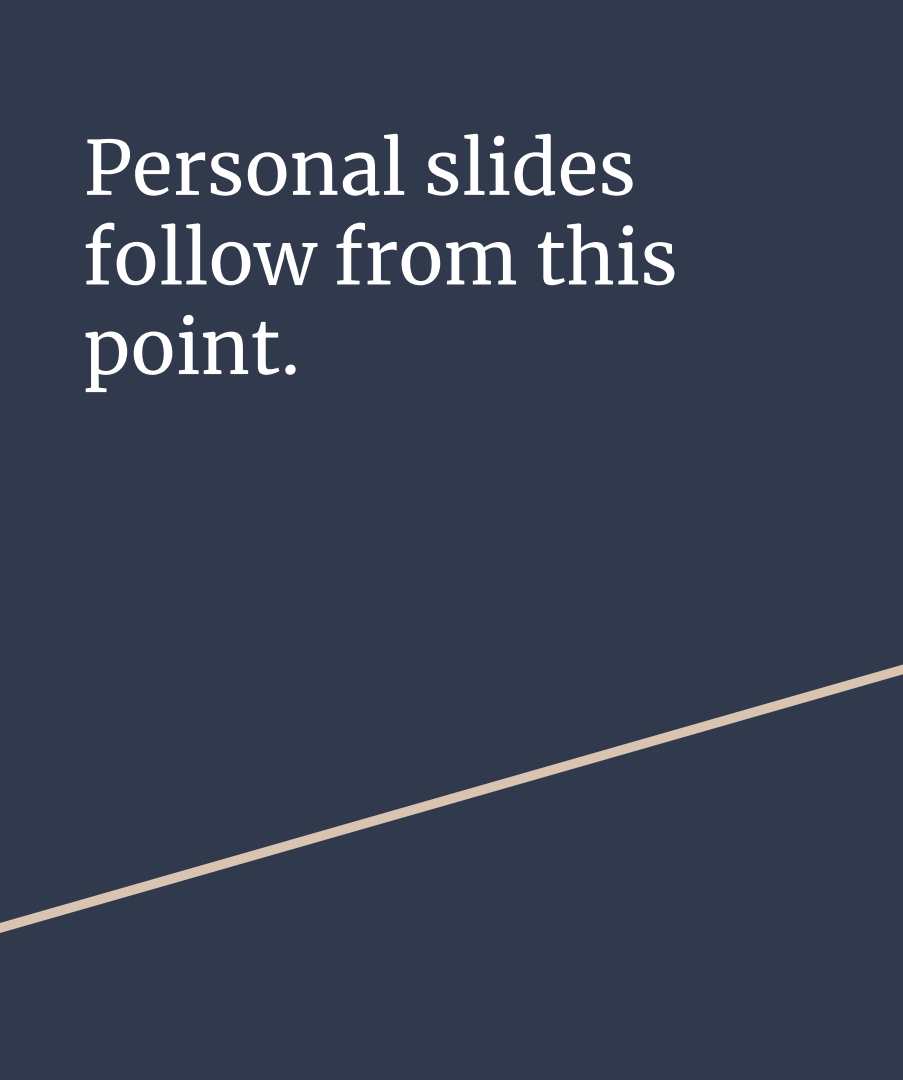# Features We Would Have Liked to Implement

Not Enough Time

- ❖ Get the GPS working
- ❖ Create a processing queue
- ❖ Start Flask server on smart box on boot
- ❖ Better SQL relationships

Possible expansion to code

- ❖ Calculate error on gps
- ❖ Car tuning
- ❖ Road data aggregation
- ❖ Display segment data on app when a Polyline is clicked

Personal slides follow from this point.

Evan Mills

- General Research on the algorithm - Minor
- Creation of acceleration to displacement script - Medium
- Creation of general High pass filter script - Medium
- Wiring of sensors to the raspberry pi - Major
- Research on duplicating raspberry pi image and settings - Medium
- Setup script used in creation of new smartbox - Major
- Data collection interrupt - Major
- Integration of Flask server, data collection script, and sensor interrupts - Major
- Website update - Minor

Alex Irlbeck

- Research on the algorithm - Medium
- Made the Java -> Python -> Java transition point - Major
  - A Java class that prints data to a file, which then calls the algorithm on said file, and returns the data to be stored.
- Created a baseline data storage object for storage in SQL that was to be modified- Medium
- Created the python script for calls on Evan's Python methods - Minor
- CI/CD - (Sunday for 30 minutes, was Ben's job)Minor
- Website updates-Minor
- Server Debugging-Major over last 3 days.

Patrick Gustafson

- Application testing on iOS device (Medium)
- CI/CD configuration (Medium)
- Research on data collection script from raspberry pi to phone (Minor)
- Research on how to start/stop data collection (Minor)
- Website updates (Minor)
  - Application documentation on how to run app via iOS device

Riku Morishima

- Wrote down notes with meeting with client for important concepts and implementation (Minor)
- Make algorithm to convert the raw data in JSON to format to which IRI calculator script likes (Medium)
- General research on IRI (Medium)
- Server Debugging- Major over last 3 days

Drew Schmitt

1. Implemented ability to see map as well as polylines on the map (Major)
2. Upload/download data from raspberry pi/server (Medium)
3. Implemented JSON parsing of IRI data to display polylines on the map from that data (Major)
4. Added real-time data updating with pull to refresh in the raw data file list and the IRI data file list (Minor)
5. Implemented deletion, viewing and renaming of raw data files from the list (Medium)
6. Wrote base functionality of Flask server for smart box (Medium)

Ben Schroeder

- Implemented database storage (Major)
- Created ability for phone to link to server (Major)
- Created way to digest output object into a storage friendly format (Minor)
- Researched into IRI basics and algorithm computation (Minor)
- Soldering work on smartbox (Minor)

Dylan Hanson

- Implementation of the data collection script on the raspberry pi (Major)
- Configuration of sensors to collect at specific hertz. (Major)
- Research on how to send data between the raspberry pi and app (Medium)
- Research on how to start and stop data collection (minor)