

Development of a Smart Sensing System for Road Performance Data Collection

Client: PROSPER: Program for Sustainable Pavement Engineering & Research

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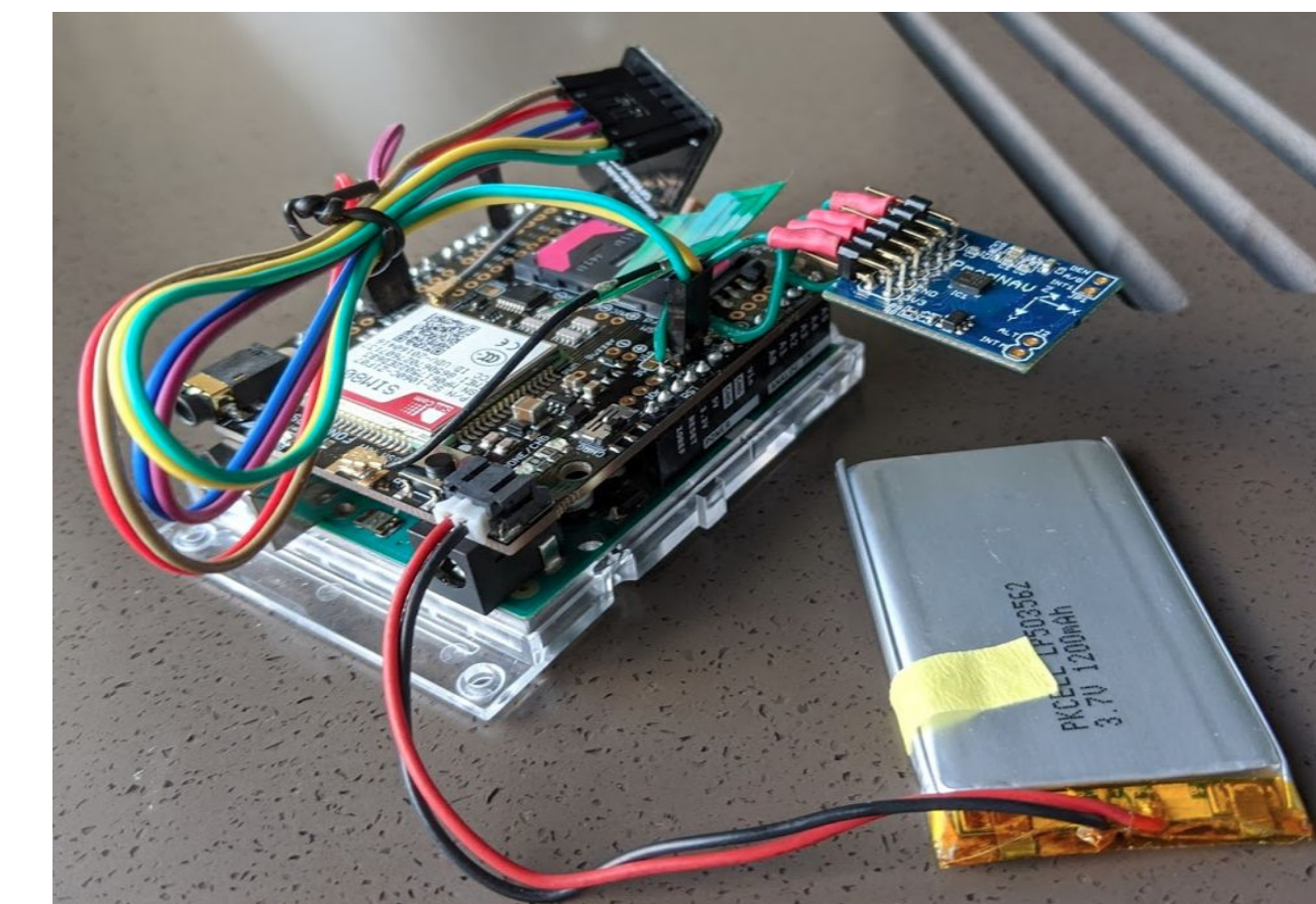
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Introduction & Motivation

- Iowa Department of Transport (IowaDOT) measures road roughness to gauge which roads need maintenance
- Measured with standard: International Roughness Index (IRI)
- Expensive laser solutions exist, but cheap hardware using mathematical models can perform task while scalable

Intended Users and Uses

- Iowa Department of Transport (IowaDOT)
- All fleet vehicles
- Priority indicator for roads



Design Requirements

Functional Requirements

- Accurate road profile measurements
- GPS mapping
- Server capable of handling large scale data processing
- Profile to IRI using ASTM E1926-08 standard.
- Database for storing IRI values

Non-Functional Requirements

- Weather resistant and shockproof
- Minimize cost to allow for large scale production
- Minimal Human Interaction required
- Low Maintenance costs/time

Engineering Standards & Design Practices

- ASTM E1926-08: IRI calculation standard
- RFC 2616: HTTP standard
- ECMA-404: JSON standard
- Small scale RTOS for Arduino

Design Approach

Back-end Server

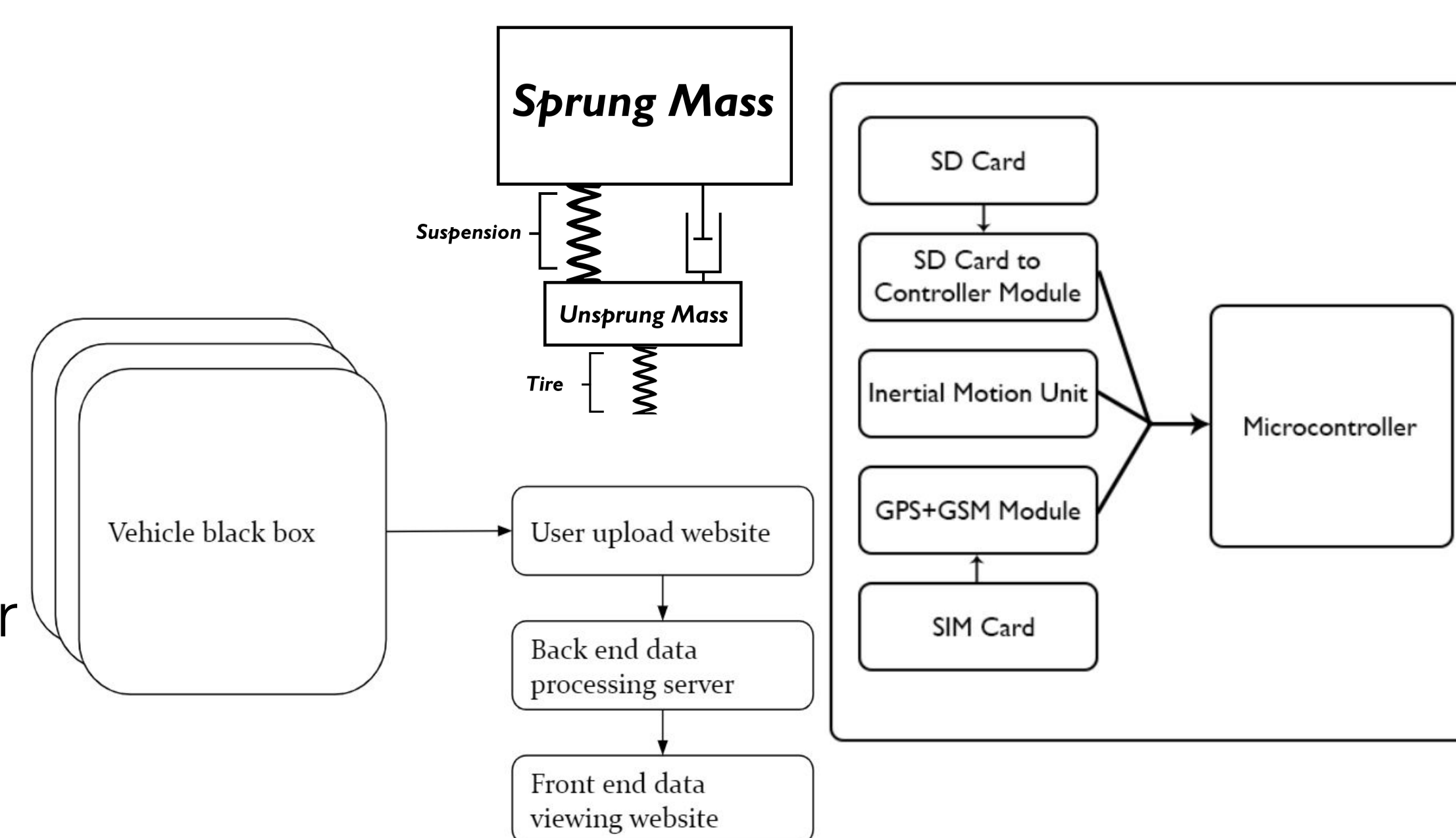
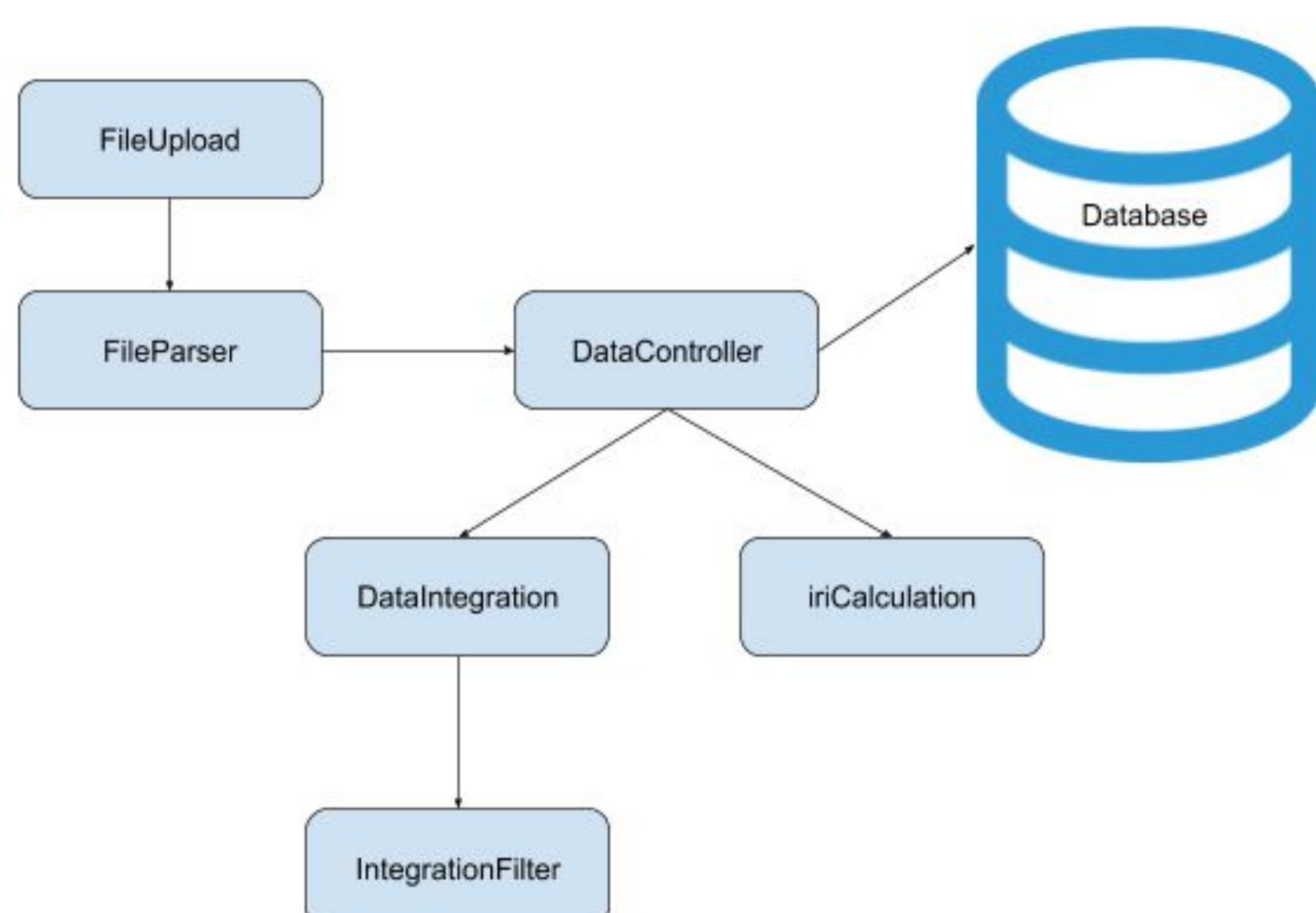
- Scalable database
- Large data sets
- Easy maintenance

Front-end Site

- User friendly
- Multiple components

Client Box

- Modular
- Arduino-based
- Use physics models for scalability (quarter car & golden car)



Technical Details

- Single black box device sits on dashboard above wheel well
- Arduino Uno with FONA 808 2G/GPS module, SD module, inertial motion unit (IMU) module
- Back-end Azure server
 - Node server
 - MySQL Database
 - Javascript modules
 - File retrieving and parsing
 - Data passed to controller
 - Integrating and filtering
 - Converting profile to IRI standard
 - Data passed from controller to database
- Front-end Site
 - React, HTTP file upload
 - Table component to display database



IRI	Latitude	Longitude	Speed
0.311397	42.05637741	-93.6481018	72.65
5.6355	42.05637741	-93.6481018	72.65
2.23849	42.05636978	-93.64835357	75.08
2.12747	42.05636215	-93.64859008	75.39
0.385021	42.05636596	-93.64910125	73.28
0.80601	42.05636215	-93.64934539	72.43
2.74637	42.05634307	-93.64981079	72.41
0.165254	42.05636215	-93.65005493	72.08
5.50418	42.05636215	-93.65005493	72.08
1.53937	42.05634689	-93.65029907	72.75
3.083	42.05634689	-93.65053558	72.89
2.66661	42.05631163	-93.65078735	72.93
3.89561	42.05631163	-93.65102386	72.45
0.286965	42.05632781	-93.65128326	71.76
0.435252	42.05632781	-93.65151977	71.12
2.31218	42.056324	-93.65176391	71.02
11.9494	42.05631637	-93.65200042	70.99

Testing & Results

- Node testing script and console
- Postman for API testing
- Data collection from actual prototype device used for server upload
- Filtering method experimentation
- XY-acceleration detection experimentation
- High precision laser rig road profile builder for comparison (incomplete due to pandemic)

