Smart City Infrastructure Monitoring

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Background

The estimated rate of bridge failures in the United States is between 87 and 222, with an expected value of 128. Though this is not a big number for the entire nation, it is enough to warrant concern for people who commute over bridges every day in their daily lives. To ease the stress over bridges that may potentially collapse, traffic routing can be performed in order to prevent a bridge from being overload.

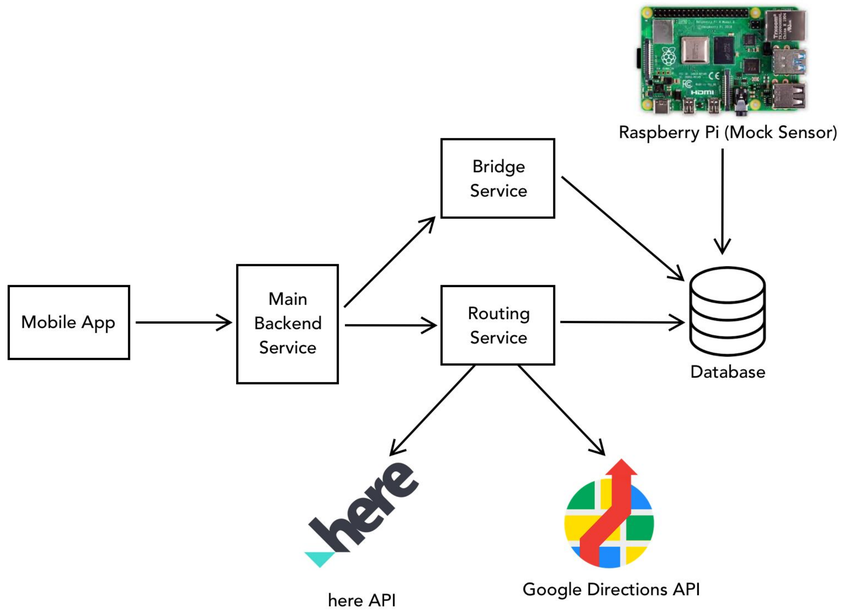
Project Goal

- To use the data collected to design a routing algorithm that would help to put less strain on infrastructure, allowing the user to be able to safely navigate and also to preserve our infrastructure to last for longer
- Integrate real time sensor data, database and statistical decision making procedures into a multi-disciplinary cohesive system.
- Learn how to collaborate with a team and work with industry leaders on cutting edge innovation to help better existing systems.

Materials Needed

- Raspberry Pi (1)
- Laptop
- Google Cloud Platform
- Mobile Devices

Solution Design



Design

- Raspberry Pi will represent one bridge, and based on the amount of cars simulated, will calculate and then forward the Bridge Condition Index (BCI) to our centralized server.
- Based on the BCI in the database, with every user request, the backend will generate a probability that will decide if the user will be able to route through the bridge.
- The route will then be shown on MapBox with turn by turn navigation in the front end

Notes

- Abstracting bridge health into a single score makes the system agnostic to the calculation of bridge health.

Progress

1. Implement the collection and processing of map data in our backend
2. Develop the routing algorithm using HERE API
3. Run integration and regression tests

Challenges

- Computing optimal route in real time
- Turn by turn navigation
- Complete integration and regression tests

References

[1] Cook, Wesley. “Bridge Failure Rates, Consequences, and Predictive Trends.” *Bridge Failure Rates, Consequences, and Predictive Trends*, 2014.
[2] Aktan, E., Chase, S., Inman, D., and Pines, D. 2001. Monitoring and Managing the Health of Infrastructure Systems. Proceedings of the 2001 SPIE Conference on Health Monitoring of Highway Transportation Infrastructure, SPIE, March 6-8, 2001.
[3] “2019 Bridge Report.” American Road & Transportation Builders Association, 2019.
[4] S.B Chase et al, “Synthesis of National and International Methodologies,” Office of Infrastructure Research and Development Federal Highway Administration, McLean, VA, USA,Tech. Rep. FHWA-HRT-15-081, May 2016.

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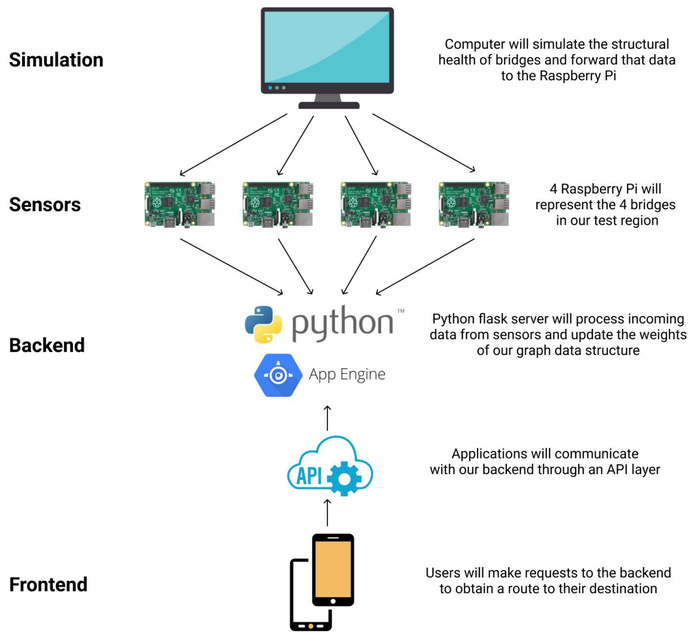
Materials and Resources

- Raspberry Pi (4 - one per bridge)
- Laptop
- Google Cloud Platform
- Mobile Devices

Solution Design



Design

- Use existing Matlab model to simulate bridge health based on vibration data and bridge load.
- 4 Raspberry Pi's will represent 4 separate bridges, forwarding the bridge health data to our centralized server.
- Update the weights within our graph representation of map area when data is forwarded from Raspberry Pi's.
- Users will make requests to the backend to get a list of coordinates, representing the route they should follow.

Notes

- Abstracting bridge health into a single score makes the system agnostic to the calculation of bridge health.
- Simulation lowers cost of sensors and data collection, but limits us to existing real-world datasets.

Milestones

Fall Quarter:

- Find and tune existing bridge vibration model to fit our project needs
- Connect Raspberry Pi with internet to send and receive data from our backend
- Complete initial setup for mobile application
- Run tests on the components above

Challenges

- Discerning accurate data sets to emulate the bridge model
- Computing optimal route in real time

Future Work

Winter Quarter:

- Collect and backfill map data into our backend
- Develop the routing algorithm
- Develop UI for the mobile application to receive directions
- Run integration and regression tests

References

1. Cook, Wesley. "Bridge Failure Rates, Consequences, and Predictive Trends." *Bridge Failure Rates, Consequences, and Predictive Trends*, 2014.
2. Aktan, E., Chase, S., Inman, D., and Pines, D. 2001. Monitoring and Managing the Health of Infrastructure Systems. Proceedings of the 2001 SPIE Conference on Health Monitoring of Highway Transportation Infrastructure, SPIE, March 6-8, 2001.
3. "2019 Bridge Report." American Road & Transportation Builders Association, 2019.