Real Time Route Optimization

PROJECT PLAN

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1 Introductory Material

1.1 Acknowledgement

Our client, Mr. Adam Ryan from Henderson Products Inc., will provide us the database runs out of sensors of machines for testing our solutions through progress, and pre-treat roadways for our initial route design. Our adviser, Prof. Goce Trajcevski, provides us with valuable advices on our decision and planning throughout the semester.

1.2 Problem Statement (2 paragraphs+)

There is a lot of bad conditions of snow weathers in North America, which makes majority of inconvenience road conditions every year. There would be traffics in some situations if the snow plows have low outcomes or duplicated tasks in their operations. So, a efficient and manageable ice removal system is necessary.

In our solution, a web-based control systems will be created to share necessary data between fleet of trucks and arrange the tasks efficiently. We will use snow plows' information that comes from sensors, such as supply details and locations. By sending to central computer with optimized solutions that runs out of our algorithm, the center control system will be able to manage and re-route the trucks for a better outcome.

1.3 Operating Environment (one paragraph +)

Our final product is a web application and will be used by dispatchers in Henderson Products Inc.. Since it is a web-based design, it will not be relevant to physical environment. It will require to use specific local and online system with data that fits and operates the software solution from our design.

1.4 Intended Users and Intended Uses (two paragraph +)

Our project Real-Time Route Optimization is to optimize the route of the snowplow and reduce the resources wasted during the movement. There are two types of user which is the Henderson's dispatcher and truck driver.

The dispatcher's task is to assign the route and purpose of each snowplow, and return the base to refill the supply if the snowplow has few resources (local resources include: salt, Gasoline and sand, etc.). In this process, the snowplow may pass the same route and cause waste of resources. Our project is to help Henderson's dispatcher to properly distribute the snowplow and maximize resources.

Truck driver can use our develop mobile app to receive information from dispatcher and local sensor. This software can be used to display the location of the truck and receive instructions from the dispatcher. At the same time, the phone can display the local

resources of its own truck, such as the salt and sand in the car, these resources can be transmitted to the phone through the sensors.

1.5 Assumptions and Limitations

Assumption:

1. We expect to complete the software by the end of March and conduct extensive testing in April to ensure that the final product will be available in May.
2. The maximum number of simultaneous users will not be limited.
3. Since the main colors on the company's icon are red and black, we will use these two colors on the most of interface.
4. The end-product will not be used outside the United States.

Limitations:

1. Because our final product is used to provide the best route for snowmobiles, our real-time testing must be carried out during the snowing period.
2. The amount of concurrent access to the software depends on the speed of the company's servers and the quality of the software's internal algorithms, so the final software cannot accept a large number of concurrent accesses.

1.6 Expected End Product and Other Deliverables

In the end of this semester(Fall 2019), we are expected to get a efficient snowplow arrangement system (based on web), which can handle the data from sensor. Besides, the central computer can also show user the arrangement of snowplow. It will return several routers to user, which is the most efficient way to remove the snow. There should be least waste of snowplows' driving, which means the street that has been cleaned should not be clean again. In our final presentation, we should be able to show how to system works in a simulation environment.

2 Proposed Approach and Statement of Work

2.1 Objective of the Task

1. Get various types of sensor data from AWS server
2. The sensor data is analyzed on our server and the logic algorithm is calculated to pass to the front end.
3. The front end receives the data and displays it on the map using the Google Map API.

2.2 Functional Requirements

There are two main types of users in our project, dispatcher and truck driver. The expected use case is to login to the system, display reminder information, assign tasks, and finally logout of the system. Based

On this, the functional requirements of the dispatcher include
1. Login and logout
2. Display the specific location of each truck
3. Assign the route of the truck
4. Get the sensor data on the truck
The functional requirements of the truck driver include
1. Login and logout
2. Display your own GPS location
3. Display your own resource usage
4. There will be reminders when there are too few resources
5. Receive the dispatcher command

2.3 Constraints Considerations

In this project, there are several constraints we need to consider.
First, we need to consider about concurrent access. When there are lots of users try to access the server, the server may be very slow.
Second, we need to build more effective algorithm, to making the the waste be least. Better algorithm can save lots of money to our client.

2.4 Previous Work And Literature

In this project, the previous engineer has built a strong system about sensor, which is maintained by Henderson now. The sensor data will be send to backend continually.

2.5 Proposed Design

Our project is a solution in which all sensor data is connected to a central server for algorithmic operations, and the results of the operations are returned to the front end for display.
Our design is to use Node.js to calculate the algorithm of the back-end data, and return the optimal route to the front-end. The front-end will use the vue.js framework and import it into the Google Maps interface for display.

2.6 Technology Considerations

The database part will be done using MySQL. We will create tables for each truck, and the supply and traffic conditions are stored in the table based on the real-time response speed of the sensor. Our final product will have two front ends. One is for use by dispatchers. This front end will be implemented by the vue.js framework and the google map will be displayed on the web page via the google map API. Another front-end user is the truck driver, and we will use the ionic framework to implement the main functions. The dispatcher sends the optimal route of the truck to the server through the web side and then transmits the information to the driver's mobile phone by the server.
The server for the product will be completed by Node.js. It is mainly used for data interaction at the front and back ends. Connect the database to both front ends.

2.7 Safety Considerations

Considering safety problem, there are two factors we need to pay attention.
First, we need care about the data security. Different company shall not see other groups' information.
Second, we need consider snowplow driver's security. The route we give should be safe to work.

2.8 Task Approach

We designed the following Designing Thinking process diagram for helping us define and improve our goals of the project throughout the semester. It could help know and resolve current problem by understanding steps by steps.

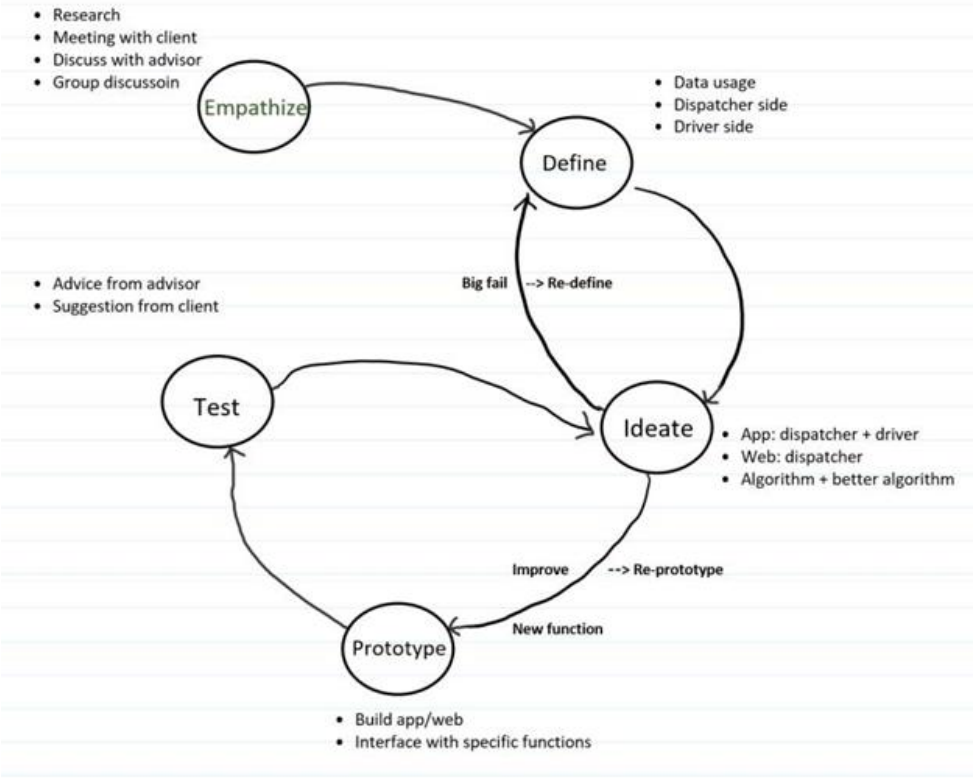

Figure 1: Designing Thinking Process

2.9 Possible Risks And Risk Management

After analyzing the entire software architecture, I think there is a framework risk theme for our project. First of all, I suspect that it is a security risk. Our sensor data is stored in the database. In authentication and authorization, data is transferred between the client and the server. However, the data is not securely encrypted. If data is intercepted during transmission, this security risk will result in the user's information being easily leaked and used. The amount of traffic to our data can be very large, which can affect server

performance and interface access speed. And the communication between the servers is very expensive.In accuracy, the sensor on the truck may be affected by factors such as the weather, so the accuracy of the data we return will be reduced.I think we should carefully analyze these existential analyses and get improved methods.

2.10 Project Proposed Milestones and Evaluation Criteria

Build a web-based app

Build a back-end server to get sensor data from AWS server

Design algorithm for re-routing trucks and send to the front-end

Front-end show the user interface by using Google Map API

2.11 Project Tracking Procedures

We will use the Trello board to record the content of our group discussions and the goals of the project. Mark the target as complete when each goal is achieved. This will keep track of the progress of our project.

2.12 Expected Results and Validation

The desired outcome is a effective snowplows management system. The central computer can get the data from the sensors in snowplow, and compute the best solution of snow cleaning.

We will test the final system by simulating of real operating environment. The simulator will send fake data to backend, to test if the central computer will get expected result.

2.13 Test Plan

1. Test the concurrent load of mobile app
2. Use simulated real-world data to test software usage

3 Project Timeline, Estimated Resources, and Challenges

3.1 Project Timeline

Table 1

Task	Time
Prototype Building	11/16/2018
mobile app	2 weeks
web frontend	2 weeks
backend	2 weeks
database	2 weeks
Adjustment & Algorithm	3/1/2019
Analyze data	1 week
Develop Algorithm	3 weeks
Adjust backend	2 weeks
Adjust frontend/app	2 weeks
Test and Reviews	4/12/2019
Design test tool	2 weeks
test and adjust	4 weeks
documentation	throughout the semester

3.2 Feasibility Assessment

In this project, there are many potential challenges in the future.

First, misunderstanding of requirement is the most dangerous part in our project. Because we rarely have chance to meet them face to face. And we are also not familiar with the snowplow using situation. Misunderstanding may lead our project to wrong direction.

Second, we need know the data format to start our early working(like building database). But the delay of getting data may also making delay of early working.

3.3 Personnel Effort Requirements

Table 2

Team Member	Contribution
Junjie Wen	Database, analyze data, develop algorithm, test and adjust , documentation
Zhanghao Wen	mobile app,adjust app, design test tool, test and adjust, documentation
Yuhang Xie	Backend, analyze data,adjust backend, test and adjust, documentation
Xinhe Yang	web front end,adjust front end, design test tool, test and adjust, documentation
Tianhao Zhao	mobile app, adjust app, design test tool, test and adjust, documentation

3.4 Other Resource Requirements

1. Sensor data get from the Henderson Company
2. Sensor hardware which can get the supply, weather and traffic information

3.5 Financial Requirements

1. Amazon Web SERVER(AWS) $650.02/ YEAR

4 Closure Materials

4.1 Conclusion

The goal of our project is to reduce time cost and financial costs and improve efficiency of snow plow operation combined with sensor system developed last semester.

Real time data from sensors employed in each truck will be took advantage to analyze decision of real-time reroute. MySQL is used to communicate and store data from AWS server which is provided by Henderson Products. Basic algorithm to meet company's goal will be implemented first and then more advanced algorithm may be discussed later. Main function of our projects will be achieved in two form: web and app. App will be built for snow driver to ensure that they understand condition of truck suck as supplies (sand, salt) and blade. Additional functions may be

implemented in the future. Web will be built for dispatcher who is in charge of overwall snow operation and send assigned routes or reroutes information to drivers.

4.2 References

No references are available at this time.

4.3 Appendices