Dynamic Routing

E90 Project
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Abstract

For our project, we propose to develop an intelligent vehicle routing system supported by a GPS and a laptop interface. The GPS device will be used to determine the current location of the vehicle relative to its final destination. A continuous network optimization algorithm will be used to dynamically route vehicles along the best route based on distance or time. The algorithm will also incorporate live traffic updates, and current road conditions in order to establish the optimal route. The laptop system will output driver directions and read them aloud so that the driver does not have to stare at the laptop.

Introduction

This project involves formulating and programming a dynamic vehicle routing algorithm. The system we propose uses a small hand held GPS device and a laptop with maps and software that are used to supplement the program and run the algorithm.

The steps to bring the project to completion have been carefully planned out and a brief description of each can be found in the Project Plan section of this proposal. The Project Plan section also contains a detailed timeline for these tasks in the form of a CPM diagram and a GANTT chart. The estimated budget for the project has been included in the Project Cost section.

Project Plan

Define an Algorithm

The first step in our project is to prepare all of the necessary background information in order to assure that all of the essential elements and details will be included in the algorithm before the programming commences. This assures that no major reworking of the program will be required at a later date.

Our algorithm will be a type of shortest path algorithm such as Dijkstra's algorithm. This considers the map as a network of line segments and nodes with a weight (distance or time) associated with each line segment. The algorithm will choose a sequence of line segments that result in the shortest path.

We would also like to model an Ant Based Control environment where we simulate traffic patterns based on a large number of vehicles using our navigation system. In the simulation environment these vehicles would constantly be communicating their location to a server via GPS that would enable the server to have the knowledge of traffic densities in various regions.

We plan to customize these network optimization algorithms to incorporate dynamic route optimization with live traffic data. The algorithm will evolve as the project

progresses, but the core must be in place in order to determine how best to construct the program that utilizes it.

Gain Familiarization with Map Software
A core piece of the project will be the map system. A database of maps, along with a program capable interpreting the GPS coordinates and integrating the results into our program will be required for the project. It is essential that we have a good grasp of how this system works, as it will provide the necessary data our network optimization algorithm, and it will convey to the user the results generated by our program.

Acquire Traffic Data
Communication has been established with the local transit authorities. The information available might be limited as far as the scope of our project is concerned and therefore may be supplemented, or replaced, with simulated data where appropriate.

Establish GPS Functionality
After the GPS has been acquired, the means by which it interfaces with our maps and software will need to be established. During the later stages of our project this will be vital to the project's functionality and thus should be established at as early a date as possible. The completion of this stage will allow us to get the GPS coordinates and display them on the map.

Program the Algorithm
This is the heart of our project and will form the basis for all future activities. Using simulated data, the proposed algorithm will be input into the program and prepared for future use. The dynamic input, the program interface and the map output will all be governed by this stage of the project.

Link Maps with the Algorithm
The process of linking the maps with the program has several steps and will be where the project finally starts to take form. The first step will be acquiring the coordinates of all the possible routes to the desired destination and feeding this data back into the algorithm. The next step is to render the output of the algorithm in our mapping system, showing the input destination, the user's current location and the optimal route to reach it. This is the stage of the project where the program will finally develop an output meaningful to an outside observer, and will be considered complete when our results can be clearly displayed to the user.

Design Program Interface
Due to the environment in which the system would be used it is vital that the user interface allow quick and easy access to all of its features. Designing this interface is a two-fold task, as it involves not only the creation of all of the necessary menus, icons, and text fields, but also the creation of a clear and precise way of presenting all of this information to the user. In order to increase the program's ease of use, storage of user profiles and frequently used destinations will be allowed, and a split screen display of information presenting both the overall route and the next point of interest will be utilized. This will be accompanied by a voice output to alert the user to the next point of interest.

Revise Program and Interface
Inevitably problems will arise as everything is integrated, thus this is a necessary phase, where these problems will be corrected and the system optimized.

Test Algorithm with Simulated Data
At this stage the live traffic data does not factor into the dynamic routing aspect of the algorithm and the testing will focus on the functionality of the simplified static form of the algorithm. Simple simulated traffic data would be used to ensure the feasibility of including live traffic data. Testing the algorithm in its basic form will considerably reduce debugging efforts at a later stage.

Incorporate Traffic Data into System
Considerable effort might be required to format the live traffic data so that it will be compatible with the maps. This data will be incorporated into the map data in order to weight roads according to traffic density for use with the algorithm.

Test System with Actual Traffic Data
This phase will involve receiving the live traffic data, reformatting it to be meaningful input for the system and using it for dynamic route modification. Basic tests will be performed to establish the functionality and debug the code.

Extensive System Tests
All aspects of the project are now functional and have been tested in their basic form. Tests that focus on the interlinked nature of these aspects will form the bulk of this testing phase. Longer routes, high traffic conditions and routes with frequent driving errors in following the route will be tested to ensure that the system is robust and capable of handling extreme cases.

Write Up
Although considerable effort will be spent documenting the various stages of the project as it progresses, these two weeks will focus on expanding and improving upon the documentation and reporting already in place.

Prepare Demonstration of System
The final aspect of the project involves a comprehensive presentation of the project and demonstration validating the functionality of our system and highlighting its uniqueness.

Table 1: CPM Task List

Arrow	**Task**	**Follows Task**	**Task Duration** (in hours)	**Task Completed** (by week)
A	Define an algorithm	-	10	1
B	Acquire maps	-	4	3
C	Acquire traffic data	-	4	3
D	Establish GPS functionality	-	3	3
E	Program the algorithm	A	20	4
F	Link maps with the algorithm	B, D	30	3
G	Design program interface	B,C,D	20	3
H	Revise interface and algorithm	E,F,G	15	1
I	Test algorithm with simulated data	H	15	2
J	Incorporate traffic data into system	I	12	1
K	Test system with actual traffic data	J	12	1
L	Extensive system tests	K	30	2
M	Write up	L	20	2
N	Prepare demonstration of system	L	8	2

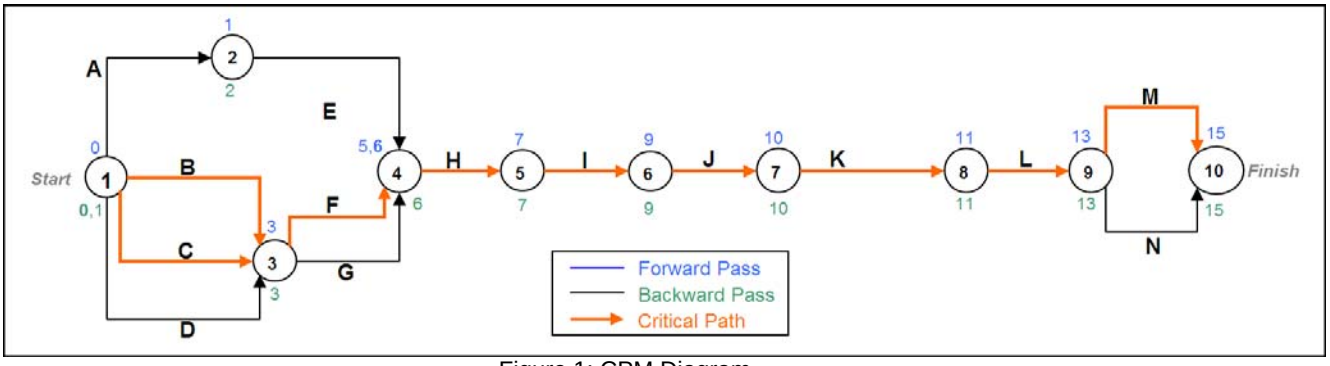

Figure 1: CPM Diagram

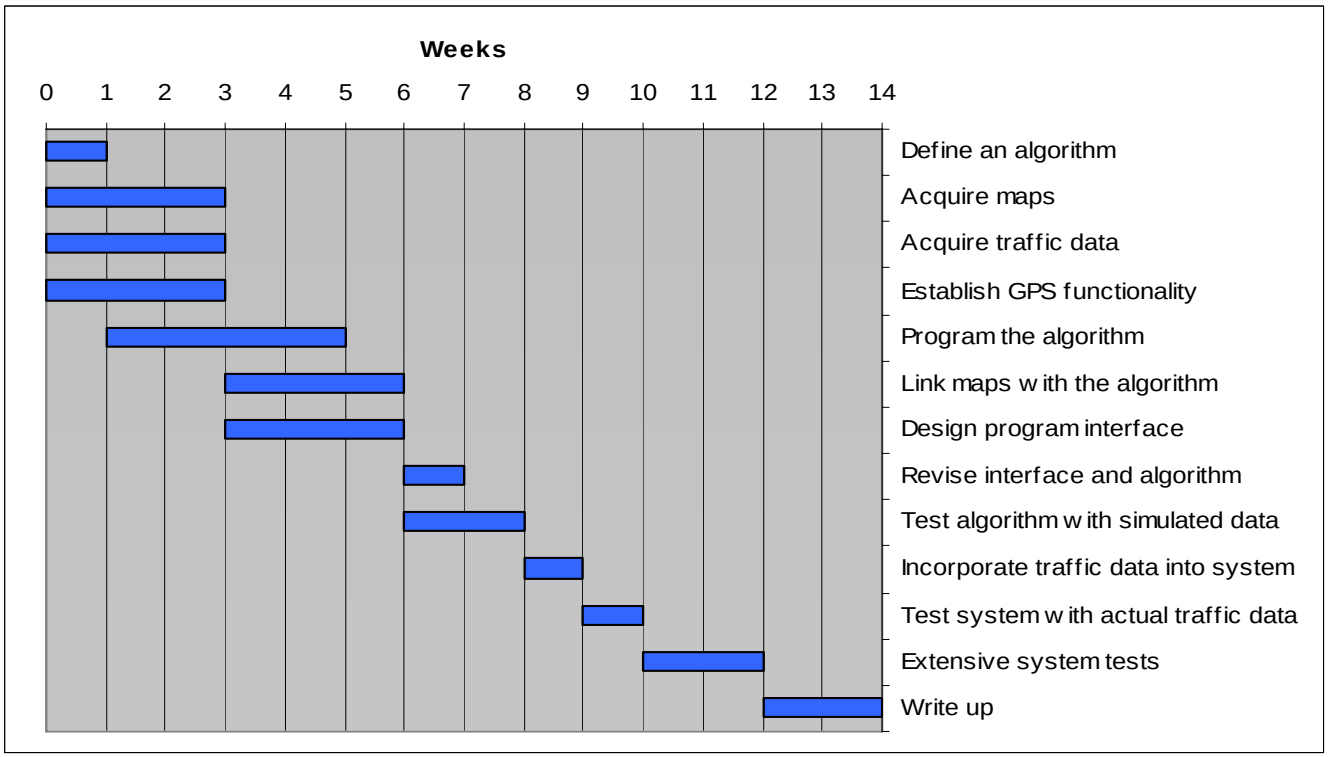

Figure 2: GANTT Chart

Project Cost

The costs for this project will consist of the following items:

Item	*Cost*
GPS	$ 200
Maps and Software (Development Package)	$ 400
Travel Expense for System Tests	$ 100

Total:	$ 700