The Unbeatable Speed Limit

New Mexico
Supercomputing Challenge
Final Report
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Team Number 90
Socorro High School

Team Members

-Omar Soliman
-Alan Benalil
-Mariah Deters
-Carly Nowicki

Teacher

- Bala Settu

Project Mentor

- LD Landis

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Executive Summary

The purpose of our project is to create a program that can calculate the speed of cars passing between two points, determine if any were speeding, and determine if any car ran a red light, stop sign, or crosswalk. This will assist the effort of police trying to lower traffic accidents, increase the security of the city's residents, enhance the efficiency of undermanned police patrols, and increase the safety of our streets.

We began by modeling our problem using Star Logo. We created a street with 2 "speed belts" that modeled the real life scanners that would monitor cars from hidden locations on the side of the road. We also modeled another street with stop signs, traffic lights, and cross walks. The user then populates the street with cars that travel at random speeds and randomly decide whether or not to stop at traffic controls. Each traffic object monitors the rate of travel and position of the cars and flags the ones that violate traffic rules. When the program is initiated, the cars drive forward and have their travel time between either speed belts recorded, while the other set of cars stops or drives past the traffic controls. We then took into account what we learned from our simulations and designed a C program that could more directly transfer data between the scenarios to a central system.

In conclusion, our program performed accurately and correctly under test simulations. In spite of this, the ultimate obstacle in the implementation of our project in reality is possible claims of privacy invasion, as the cars are individually (although anonymously) identified and monitored. However, if the public accepts this slight privacy infringement, it will more than compensate in terms of safety for everyone on the road.

Problem Statement

The bulk of our police forces these days are spending their time patrolling highways and streets watching vigilantly for people who are driving over the speed limit, running red lights or stop signs, rushing across crosswalks, and interfering with police chases. Imagine if there was a system that could calculate a car's speed between two points and verify whether it was speeding between them. If such a system existed, it would free up our thin-stretched police force and allow them to concentrate their efforts to protect and serve on more pressing matters.

The purpose of our project was to create a program that could: monitor segments of the road for speeding cars; monitor lights, stop signs, and crosswalks for traffic violations; and further track severe violators' locations using GPS.

Procedure

Description

In today's world, RF chips have become commonplace in almost every convenience, wholesale, and department store, planted on almost every product. Shoplifting alarms work by scanning for "live" chips that haven't gone through a cash register. Because RF chips are so cheap to manufacture, we believe unique chips could easily be placed on every car through the distribution of license plate stickers to motorists. By placing pairs RF scanners on the side of the road, the speed of cars passing through them can be calculated by measuring the time it takes to go from one scanner pair through another, the formula being:

$V = D/T$ → where D is the distance between the scanners, T is the time it takes the car to reach the second scanner, and V is the speed of the car.

If a car is caught speeding, the scanner can identify the ID number on the car's RF chip, flag it, and send it to a central computer. Transponders can also be placed near traffic signs/lights to monitor vehicle stoppage. If a car approaches a traffic control sign/light and its ECU/accelerometer doesn't register 0 mph, the vehicle is also flagged. This approach can be taken one step further by tracking the location of the serious traffic violators (who may be drunk drivers) through GPS satellites.

All cell phones as of early 2008 are required to have permanently enabled GPS in them by the Department of Homeland Security. OnStar is also rapidly appearing in new vehicles, and its system has a built in GPS. Our approach makes the assertion that you cannot drive a new vehicle unless you have a form of GPS (either cell phone or OnStar). The ECU in a non-OnStar vehicle will refuse to start the car unless it has a signal from a registered cell phone. The GPS transponder would then be capable of sending its coordinates to our system in case of severe traffic violations.

In order to prevent cheating the system, transponders will be placed to avoid exits/rest areas/turns that would alter apparent vehicle speed.

Assumptions

- Passing a slower vehicle is not taken into account
- Rush hour, congestion, and “going with the flow” are ignored
- All cars will have either an RF chip, GPS (in some form), or both
- Emergency speeding never occurs
- RF scanners are strategically positioned to avoid stopping areas
- Leeway allowed for in-city speed limit is 5 mph – highway is 7 mph
- An ECU or an accelerometer is located in every vehicle
- If a car goes through the first “gate” of scanners, it always comes out

Method

We began by modeling our problem using Star Logo. We created a street with 2 “speed belts” that modeled the real life scanners that would monitor cars from hidden locations on the side of the road. We also modeled another street with stop signs, traffic lights, and cross walks. The user then populates the street with cars that travel at random speeds and randomly decide whether or not to stop at traffic controls. Each traffic object monitors the rate of travel and position of the cars and flags the ones that violate traffic rules. The rule violators then leave a trail of color in their wake to simulate GPS tracking. When the program is initiated, the cars drive forward and have their travel time between the speed belts recorded, while the other set of cars either stops or drives past the traffic controls. After committing a violation however, the cars begin to move in random directions, highlighting their trail.

Taking into account what we learned from our simulations, we designed a C program that could more directly transfer data between the scenarios to a central system. In the C program, we bypassed the physical mechanics of the scenario and assumed that we could receive from the scanners directly the outcome of a traffic event (either a “1” for violation, or 0 for clean). We again modeled random speeds and probabilities and looped the program to simulate a flow of traffic.

Results

Our StarLogo model indicated that tracking vehicles using GPS on a basic computer program would prove difficult if not impossible. Our model also showed that it would be impractical to use GPS or RF transmitters to determine if a car came to a complete stop; that factor would have to be decided by an ECU transmitter/accelerometer. However, our C program performed accurately and correctly under test simulations.

Conclusion

In conclusion, our program has proven that it can be put into service in the real world. In spite of this, the ultimate obstacle in the implementation of our project in reality is possible claims of privacy invasion, as the cars are individually (although anonymously) identified and monitored. However, if the public accepts this slight privacy infringement, it will more than compensate in terms of safety for everyone on the road.

Materials

Software

OpenStarLogo 2.22 – GNU Emacs 21.3.1 – GCC for Windows XP 4.1.3

References

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[3] http://hypertextbook.com/physics/mechanics/velocity/
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[4] Interview with LD 'Gus' Landis on 12/15/07

[5] Early Transcendentals Calculus - James Stewart - Fifth Edition

Significant Original Achievement

Our most significant original achievement was the creation of a program that can potentially help bring about completely automated traffic and transportation systems, as it can act as a preliminary regulatory procedure for conducting traffic.

Acknowledgements

We would like to thank all who helped us, including our teachers, mentor, and Dr. Glenn G. Adams. We would also like to give props to New Mexico Tech for having a C compiler on their network. Thank You!