ENGR 1221 Memo

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To: Dr.Wesley Boyette
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Subject: 1221 Final Project - Automobile Cruise Control

Introduction

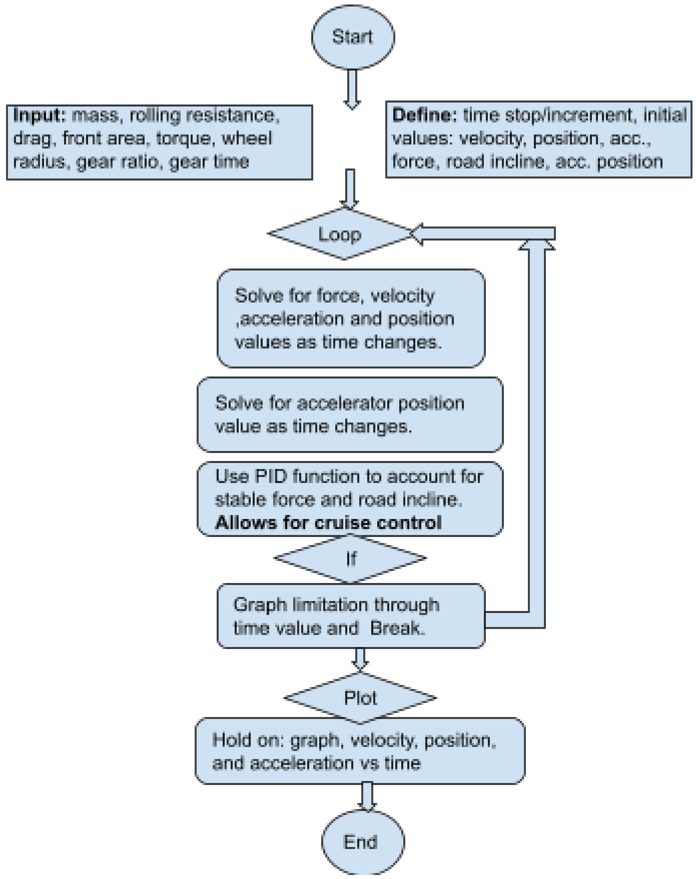
The simulation that we chose to complete was an automobile with cruise control, which has the objective of simulating the speed of an automobile based using a basic traction model. The idea and equations regarding this model was provided to us through a class provided document, which outlined the basic breakdown and requirements for our simulation. [1] The grade of the road on which the automobile is traveling on is also considered. A PID control was also used for the vehicle speed to account for how sudden change in road grades affect control parameters. In order to ensure that the simulation worked properly various values needed to be tested, especially the parameters used for the PID function. These verification values were documented in the form of a testing script. A supplementary part of this simulation is to also provide a GUI, so that potential users have a cleaner and easier way of interacting with the simulation.

Results and Discussion

In order to increase the team's efficiency, the roles for this project were split up among our team members. Edward Kill was our main programmer, and therefore placed in charge of the main simulation code. To ensure the performance of our program, Elizabeth and Dalton both helped in the roles of providing supporting code, especifically the PID control function and completing the necessary testing and verification. Finally Jonathan was placed in charge of putting everything together within a GUI.

In regards to the main automobile cruise control simulation code, the way in which our main code was organized can be seen through the flowchart shown in figure 1 below. The code consists of overall one main loop, within this loop the values of force (Fw), position(x), velocity(v), acceleration(a) where solved for. Within this loop the supplementary function of PID was also used, to help solve for the accelerator position (u). The usage of the PID function allowed us to control the vehicle's velocity by keeping a constant force; this function is arguably the most important factor for this cruise control aspect of this simulation. An if statement is also used within the loop to add a breakpoint to the future graph and prevent an infinite loop, this is done when the time of the graph becomes greater than 7.

Figure 1: Flowchart of simulation algorithm



The main portion of this simulation that allowed for cruise control was the usage of the PID function. Through testing we concluded that the optimal parameters for our PID function were to have a P value of -0.0006, I value of -0.00001, D value of -0.45, N value of 3 and a V_set value of 65.

The graph that we were able to produce at the end of the simulation suggested that while the position of the automobile constantly increased, which made sense and the automobile is still in travel, the velocity of the object changes. Initially the velocity greatly increases , due to the initial force placed upon the automobile and after a few minutes though some fluctuations are experienced the velocity stabilizes as a whole, allowing the automobile to come to a constant speed. Finally, the acceleration of the automobile seems to remain constant all throughout the travel time, suggesting that the velocity is largely increasing at a constant rate. We also noticed that when certain values, such as the V_set value were increased, the velocity of the automobile increased to a greater max, however it eventually stabilized at the same value. This can be explained by the fact that only the initial velocity set point was changed, therefore as no other values were changed, the graph would remain the same except for those initial minutes within the travel time.

Conclusions and Recommendations

Overall the final graph did make sense with what would happen in a real world scenario. As noted above, the overall graph trends of having an increasing position and velocity, along with a constant acceleration make sense. The fact that the automobile eventually comes to a constant velocity is also reasonable as the cruise control (PID function) within the program controls the force applied to the car therefore allowing it to reach and maintain a constant speed. However, there are several areas of improvement within our program. Though the results on the graph may not be exactly as one may have imagined, they make sense conceptually and perhaps with changes made to the scale of the graph could be better represented for the viewer. I also believe that our current program has a lot of limitations, such as coding for our accelerator position(u) value within the loop, as it is extremely sensitive and has limited parameters. We would also potentially like to include code that automatically takes into account the road grade that the automobile is traveling on, or perhaps has a bank of values which can be accessed. As most individuals do not have this information as common knowledge, and I believe it would help improve the usefulness and versatility of the program, further improving upon the GUI. We also ran into a few problems, specifically with the indexing of the GUI, as we kept running syntax errors when transferring the main script to the GUI, preventing the program from running properly. We also believe that the function itself could be better cleaned up to allow for an easier debugging process for others if need be. Initially this stimulation does indeed accomplish the goal that we had set out to create a program for automobile cruise control. And though there is potential for improvement, the graphical data which our simulation outputs also helps further user understanding, while accounting for several changing variables.

References

[1] ENGR 1221. (2021, November 17). Simulation of Automobile Cruise Control. OSU.