The purpose of the present study is to provide information about the motion of cars in a real cruise to develop an automatic car cruise system by Nissan motor company. A real time video of 45 seconds is employed to simulate the cruise. Video capture is discretized into time intervals and those snapshots are used to obtain motion history of the each moving object in the video by choosing several references in each snapshot. The time history of displacement, velocity and acceleration of the moving objects are employed to reconstruct the cruise in computer by using animation techniques to feed the information to designers.

1. Introduction

In today’s automotive technology, not only comfort and performance, but also safety of the passengers is an important issue. Within this scope, automatic cruise control systems appears to be important and it becomes a subject of intensive research. Nissan Motor Company is also developing such a cruise system, which requires the recognition of the motion of the target car and the cars in the traffic. A video capture of 45 seconds, shot by a very high-speed camera, is prepared to analyze the motion of the target car. It is required to reconstruct this video capture in computer to obtain data for the cruise system.

2. Theory

Reconstruction problem of images from pictures -even for still pictures- is a difficult task. When the motion pictures are considered, the amount of effort for reconstruction increases exponentially. There are several approaches for reconstruction of still or in motion images [1], [2], [3]. But, in the present study, a non-conventional and considerably simple method combined with animation techniques is to be explained.

The basic idea of the present method is to obtain “the motion history” of each moving object appeared in the motion picture, and feed this data to the computer animated reconstructed picture. The motion history is analogous to the trajectory of the moving particles, allowing to gather information about displacement, velocity and acceleration of the particle.

In obtaining the motion history of the target car and the cars moving in the traffic, the video
capture is “discretized” i.e. with small time increment $\Delta t$, snapshots are taken. Here, the decision of how small the $\Delta t$ is a compromise between the precision and computational cost. For each snapshot, at least, three different reference points are chosen in such a way that, one of the reference point is fixed and it is on the target car, and others are on the surrounding environment and arbitrary. The only necessary condition in choosing those arbitrary points, is to trace these points at least in the following one snapshot. By measuring the x and y coordinates of the reference point on the target car with respect to other reference points, the trajectory and then the velocity, and acceleration are calculated. Since the initial velocity of the target car is known or it can be assumed at $v_0$ at initial time $t=0$, from the measurements the real velocity and the real acceleration of the target car are calculated. However, for the cars in the traffic, one reference point is chosen on the moving car, the other is on the target car, therefore the velocity and acceleration of those cars in the traffic are relative ones.

![Figure 1. Typical Snapshots Having $\Delta t$ of 1 Second, the “Star” Shows the Fixed Reference Point and the Circles Are the Arbitrary Ones](image)

By measuring the change in x and y coordinates, the required histories are obtained and displacement vs. time, velocity vs. time and acceleration vs. time graphics of each moving vehicle are plotted. Here, since it is assumed that the road is straight with no slope and a very high speed camera is used in capturing and discretization is done with very small $\Delta t$’s, the errors due to perspective changes in the pictures are negligible in the engineering sense.

These motion histories are used to reconstruct the motion picture in computer. Simple animation techniques are used for this purpose. 30 pictures per second, which can be considered as a satisfactory resolution in animation, are prepared. Since, at any time, the parameters defining the motion of the vehicle(s) can be determined from the motion history plots, and since the resolution is predefined, the reconstruction of the motion picture in this way can be considered as an application of particle motion in elementary physics.

3. Conclusions

In this study, a very simple but also very precise method for motion reconstruction for cruise control is presented. The possible errors, which may be encountered due to perspective changes, or due to
irregularities of the road in the third-dimension are negligible in the practical engineering sense. Therefore, it is possible to say that the present method can be used satisfactorily for reconstruction of motion pictures and the precision can be improved by choosing smaller time intervals in discretizing the movie.

4. References