

Chapter 8

Vehicle Location and Navigation Systems

Ben-Jye Chang

National Yunlin University of Science and Technology, Yunlin, Taiwan, R.O.C.

ABSTRACT

The most driving purpose is to traverse to the destination safely, efficiently, and comfortably. Two types of approaches could achieve the goals, including the static and dynamic approaches. In the static aspect, vehicles use the static road and traffic information to navigate. Conversely, in the dynamic aspect, vehicles adopt the dynamic information instead. However, both of the two approaches first require getting the vehicle's location and then map the position on an e-map. Thus, this chapter first introduces some important vehicle location determination algorithms: the dead reckoning and global position system algorithms, in which the precision of location technologies are compared. Then, the map-matching algorithm is described in detail. Finally, various vehicle navigation approaches are detailed, in which the important topics include: the navigation architecture, the navigation routing algorithm, and navigation applications.

INTRODUCTION

The invention of the vehicles, though it could shorten the distance from place to place, has brought a lot of serious issues: traffic jam, car accident, energy crisis, environmental pollution, etc. Moreover, as the population rises and living in standard increases constantly, the vehicles are everywhere and the roads are even more complicated. Finally, it would not

only waste our time, but social cost. Therefore, transportation simplification, driving time reduction, and energy conservation are the top priority concern of the world. Thus, this chapter, Vehicle Location and Navigation Systems (Farrell et al., 2008; Zhao et al., 1997), are what we researched. While the vehicles are moving, realizing your location, destination and the shortest path are important. However, most of all, you know where you are, or other conditions are useless. The early days of vehicle position are a driver reads maps and road signs in the meantime

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and finally reaches its destination. It is inefficient and dangerous still. Moreover, wasting resources and other problems could occur by vehicles position. Generally, vehicle position can be divided into two methods: early days' dead position and current used GPS technologies.

For locating a vehicle position, the vehicle with dead reckoning method must set its coordinates before moving. Position and distance sensors, based on the coordinates, could figure out tracking movement and turning degree. Lastly, the current position could be located.

For example, as shown in Figure 1, the starting point (x_0, y_0) , the based point also, multiplied by each distance d_i and aspect θ_i is the terminal point (x_n, y_n) . The formula becomes as follows:

$$\begin{aligned} x_n &= x_0 + \sum_{i=0}^n d_i T \cos \theta_i \\ y_n &= y_0 + \sum_{i=0}^n d_i T \sin \theta_i \end{aligned} \quad (1)$$

Distance and position sensors are applied by dead reckoning method. The following contents in this book would discuss both two common sensors.

Distance sensor normally applies speedometer to plot the moving distance. The application makes use of the sensor device, which can calculate wheel turns, on the wheel axle. Circumference of the wheel multiplied by the wheel turns is the distance.

Figure 1. Dead reckoning

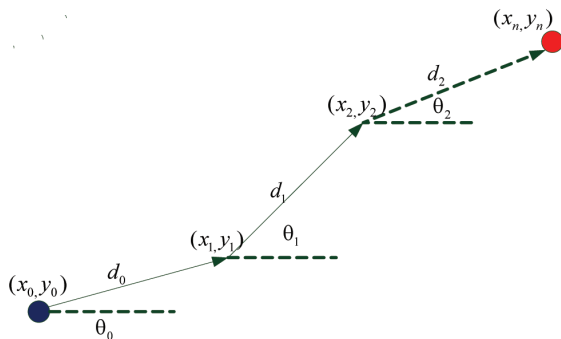
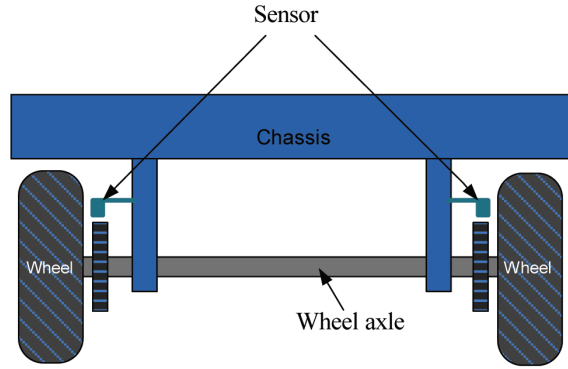


Figure 2. Distance sensor device



However, the results could be a huge error due to different wheel sizes and terrains (e.g., idle running of wheels on the snow and sand). Distance sensors are subdivided into mechanical and electronic ones. Figure 2 is a typical example.

The vehicle position sensors enable position measurement. It can either be an absolute position sensor or a relative one. The first one applies the earth's magnetic field to get absolute position. Figure 3 shows that the induction coils can be affected by the earth's magnetic field and the vehicle's position can be measured can by the angle θ , as demonstrated in equation 2. However, using earth magnetic field to induct position has a disadvantage. That are the results are easily affected by some circumstances: viaducts, bridges, substation, and high-voltage tower. Conversely, the relative position is determined in terms of the original point and angle.

$$\theta = \tan^{-1} \frac{V_x}{V_y} \quad (2)$$

Dead reckoning was mainly used in the past with three disadvantages: 1) Based point should be located well, 2) The sensor has huge error, and 3) The more distance you move, the more error could be.

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