
Primary Report

# Adaptive Cruise Control

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## CHAPTER 1: INTRODUCTION

Cruise control is a system that automatically controls the speed of a motor vehicle. A cruise control system was developed for highway driving, useful for driving in the roads which are big, straight, and the destination is farther apart. There are two types of cruise control systems.

1. **Conventional Cruise Control**
2. **Adaptive Cruise Control** [4]

Adaptive Cruise Control (ACC) is an intelligent form of cruise control that slows down and speeds up automatically to keep pace with the car in front of the host car. The Adaptive Cruise Control (ACC) system was introduced in Japan as an Advanced Driver Assistance System (ADAS).

When traffic congestion increases, conventional cruise control becomes less useful. Hence to cope up with the situation adaptive cruise control was introduced. ACC provides with two modes of control, that is,

- Velocity Control
- Distance Control

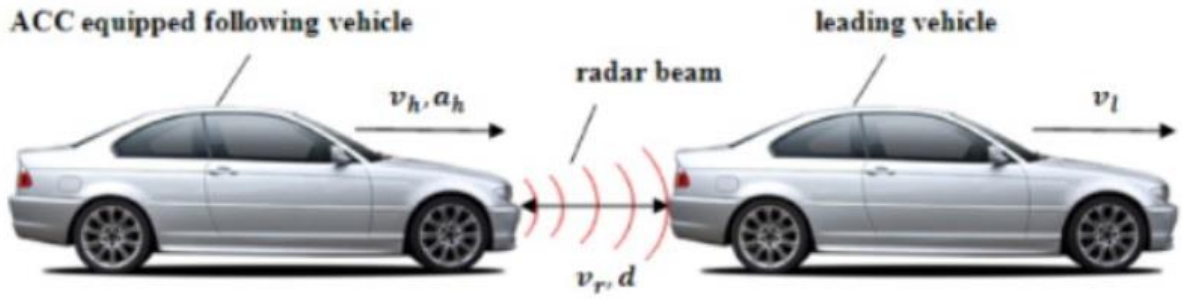


Fig 1: An ACC equipped vehicle following another vehicle in front. [2]

ACC can automatically adjust velocity in order to maintain a proper distance between the obstacle and the vehicle equipped with ACC. This is achieved by using a laser or radar to measure the relative distance between the host vehicle and a vehicle in front.

A vehicle with ACC adapts to changes in the speed of the vehicle that precedes it. In standard control terminology, non-adaptive cruise control is open-loop control, whereas ACC is closed-loop control [3]. There are two types of Adaptive cruise control system:

1. **Low-Speed ACC:** Operates under congested traffic to maintain the distance behind the obstacle vehicle. This type of ACC system is sometimes called “stop-and-go ACC. [1]
2. **High-Speed ACC:** It is the evolution of cruise control. The system provides velocity control as well as vehicle-to-vehicle distance control mode, which assists the driver by adjusting vehicle speed (within a set range) to help maintain a pre-set distance to a preceding vehicle when the preceding vehicle is traveling at a slower speed. [4]

## CHAPTER 2: OBJECTIVE

The idea of building an Adaptive Cruise Control using Simulink will be aiming to let the driver in a host car set a traveling speed and automatically maintain a constant distance from the preceding car. When the preceding car gets closer, the host car slows down on its own and when the preceding car speeds up, the host car also gains the speed. This project comprises of ACC system operating at moderate to high velocity, 40 and above.

The adaptive Cruise control system is a primary step toward autonomous driving in which the car controls its own speed and distance from other vehicles. [7]

## CHAPTER 3: PROJECT DESCRIPTION

The project describes how the adaptive cruise control works with the usage of five components that are Arduino UNO, Buttons, Distance sensor, and 7-segment anode display. Five buttons are used for speed attributes such as increased speed, decrease speed, set speed, adaptive speed, and cancel. The increased speed and decrease buttons are triggered for increasing and decreasing the speeds. Moreover, when the set speed button is pressed, at that time the system enters the cruise control mode where the speed is held constant. In this mode, the increased speed and decrease speed buttons can still be used. To exit the cruise control mode, the cancel button is to be pressed. When the adaptive speed is pressed, the increased speed and decrease speed buttons are not functional. In this mode, speed is calculated based on the object appears in front of the vehicle automatically. The vehicle will reduce its speed when an object is detected as well as when the road becomes clear, speed will start to increase to attain the set speed. For exiting this mode, the cancel button is required. To differentiate between cruise control and adaptive cruise control mode, the system keeps blinking in the adaptive cruise control mode rather than the cruise control mode.

## CHAPTER 4: DEVELOPMENT PROCEDURE

Adaptive cruise control is similar to conventional cruise control in that it maintains the vehicle's pre-set speed. However, unlike conventional cruise control, this new system can automatically adjust speed in order to maintain a proper distance between vehicles in the same lane. This is achieved through a Radar sensor, Arduino UNO, five Buttons and 7-segment anode display. If the lead vehicle slows down, or if another object is detected, the system sends a signal to the engine or braking system to decelerate. Then, when the road is clear, the system will re-accelerate the vehicle back to the set speed. [5], [6]

### 4.1 MATLAB SIMULINK:

The dynamics for the preceding car and host car are modeled in Simulink. The ACC system operates in the following two modes:

- Speed control: The ego car travels at a set speed.
- Spacing control: The ego car maintains a safe distance from the lead car.

When the speed control mode is active, the control goal is to track the set speed. The ACC system is modeled using the Adaptive Cruise Control System Block in Simulink. The inputs to the ACC system block are:

- Set the speed of the host car.
- Increase speed
- Decrease speed
- Adaptive speed
- Cancel [8]

This whole system is working through the MATLAB Simulink software. The process starts by installing Simulink packages from the add-on option available in MATLAB Software which will help to connect the Arduino UNO to these packages. Further, the blocks are added from the library browser which includes ultrasonic sensors, analog input, analog output, RGB LED and many more which are further configured to set the properties. The output for the ACC system is the acceleration of the host car. The safe distance between the host car and obstacle is a function of the host car velocity.

Here, first, we are initializing the system and afterward, we will set the speed at 40. When the adaptive set speed is pressed, the set speed is held constant and the increased speed and decrease speed buttons will not be functional. At that time, when the obstacle is detected by radar, the system will decrease its speed to avoid the collision and a safer distance is maintained between two. When the path gets clear, the speed will start to increase to its set speed. If the cancel button is pressed, then it will come out of the adaptive cruise control mode. For using the cruise control mode, we need to set the speed by set speed and then we can use the increased speed and decrease speed buttons, for quitting this mode, again we have to use the cancel button.

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