AUTOMOBILE RADAR

Elie J. Baghdady
Info Systems, Inc.
San Diego, California 92111

Abstract

Miniradars utilizing the Doppler phenomenon have been developed for sale to the general public in the car after-market, as well as to car manufacturers, for providing safe-following headway control of car motion, and for detection of road hazards and collision threats both in front and in the back blind spots. Application to collision-anticipatory sensing for air-bag inflation and integration with anti-skid devices are also significant developments.

In this paper, the essential requirements of the cited applications, the techniques that render radar economically feasible for the consumer market and the performance capabilities of the current car-installed equipment are reviewed briefly.

Summary

Radar techniques can be applied in automobiles to eliminate, or at least minimize, dependence upon a driver's full consciousness of traffic and road hazards, judgement of the degree of safety (or rather unsafety) of ambient driving conditions, vision or sighting capability over a 360-degree field, and reaction time to sight, judge, recognize the need for and exercise the proper degree of precautionary reaction - - ranging from increased alertness, to actual initiation of the proper type and measure of preventive control to avoid completely, or at least reduce the intensity of, an impact. Technically, the problems resolved can be categorized into safe-following headway control, anticipatory sensing of collision (front-end or rear-end), automatic brake control to avoid a collision or reduce its impact, detection of hazards in front or in rear blind spots. The essential objective in all of these accomplishments is to supplement the capabilities of a driver by a motion and road-hazard monitoring and collision threat assessing device that is pre-set by experts to perform these vital functions continuously and consistently regardless of the physical and emotional conditions of the driver. In principle, only the functions of initiating the drive and steering the motion are left entirely to the driver. Manual, and in some circumstances automatic, override returns full control of the vehicle to the driver when desired.

Of the various driver-aid sensing and warning or control functions listed above, safe-following headway control is the most elaborate. Four parameters are utilized in the automatic decision of whether, what and how much control should be exercised for safe-following:

a. Relative distance to the obstacle,
b. Closing speed,
c. Absolute speed of equipped vehicle, and
d. Ratio of safe relative distance to car speed characteristic of make and model of equipped vehicle.

There are safe and unsafe combinations of the above parameters. "Safety" is judged in terms of allowable separation between vehicles for a specified equipped vehicle speed and allowable closing speed for a given separation. When the system senses an unsafe combination, it actuates throttle control and commensurate braking action to bring the speed and distance parameters within the preset "safe" ranges.

The mass, engine and brake set-up of a vehicle determine its response characteristics to changes in gas injection and to the application of various degrees of braking action. These characteristics are taken into account in optimizing the control settings for a given vehicle. These settings can be either pre-set conservatively for a prescribed range of road surface conditions, or some degree of adaptivity can be provided to allow different margins of safety for dry and wet pavement conditions.

Extensive evaluations and experimentation with various promising radar signal designs and signal processing techniques have led to the selection of approaches and the development of novel functional and circuit implementations that make it possible to perform the desired operations within price guidlines recommended by car dealers.

The final product is modularized into simple blocks. Installation in a particular vehicle can be made by ordinary mechanics with no machining or heavy mechanical work required. The radar unit operates entirely from the battery of the vehicle, and uses all-solid-state components and construction techniques normally employed in compact, ruggedized aerospace electronic modules.

Notes