Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 114 (2017) 523–530

Procedia Computer Science

www.elsevier.com/locate/procedia

Complex Adaptive Systems Conference with Theme: Engineering Cyber Physical Systems, CAS
October 30 – November 1, 2017, Chicago, Illinois, USA

An Empirical Study to Investigate the Effect of Air Density Changes on the DSRC Performance

Mostafa El-Said*, Vijay Bhuse, Alexander Arendsen

School of Computing and Information Systems, Grand Valley State University, Allendale, MI 49401-9403
University of Central Florida, Computer Science Dept, 100 Weldon Boulevard, Orlando, FL 32816

Abstract

The primary role of Intelligent Transportation Systems (ITS) system is to implement Advanced Driver Assistance Services (ADAS) such as pedestrian detection, fog detection and collisions avoidance. These services rely on detecting and communicating the environment conditions such as heavy rain or snow with nearby vehicles to improve the driver's visibility. ITS systems rely on DSRC to communicate this information via a Vehicle-to-Vehicle (V2V) or Vehicle-to-Infrastructure (V2I) communications architectures. DSCR performance may be susceptible to environmental changes such as air density, gravitation (gravitational acceleration), air temperature, atmospheric pressure, humidity, and precipitation.

The goal of this research is to investigate whether the DSRC performance persist with respect to air density changes in a foggy environment. Simulation experiments are setup using PreScan to study the influence of changing the air density on the DSRC performance in a foggy environment using V2V communications. The PreScan simulation experiments are carried out over a wide range of air density levels that start from an extremely low value of (0.05 kg/m^3), a normal air density level of 1.28 kg/m^3 to a high altitude with air density level of (50 kg/m^3). The study uses this wide range of air density levels to allow us to determine the influence of the air density on the DSRC performance and explore any performance inconsistency if there is any. The research findings proved that the DSRC performance can persist through air density changes, which helps to make up for lost human visibility on roads during foggy times. This finding aims to promote safe highway operations in foggy conditions.

Keywords: VANET; ITS; DSRC; Fog and Smoke; Air Density; Visibility

* Corresponding author. Tel.: +0-616-331-8686; fax: +0-616-331-2106.
E-mail address: elsaidm@gvsu.edu

1877-0509
10.1016/j.procs.2017.09.025

1. Introduction

Self-driving vehicles are the next generation of the auto industry and they will be used all of the over the world by 2025. Moreover, IEEE predicts that up to 75% of vehicles will be driverless by 2040. This will lead to a dramatic change in the Intelligent Transportation Systems [1]. Therefore, as future driving becomes more autonomous (driver-less), vehicles will be equipped with a wide variety of sensors such as the ones shown in fig. 1 [2]. These sensors are used to observe, collect different types of information such as vehicle's speed, dimensions, heading, braking status and environmental conditions such as fog, cloud and amount of rain. This data will be collected using short range sensors such as: (1) Radars (Radio Detection and Ranging) for detecting nearby objects including human body or other vehicles, (2) 360 degrees camera system for mirroring 360 degrees around the vehicle, and (3) LIDARs (Light Detection and Ranging) for detecting objects by sending out a laser beam and measuring the reflected signal to determine the distance between the vehicle and surrounding objects.

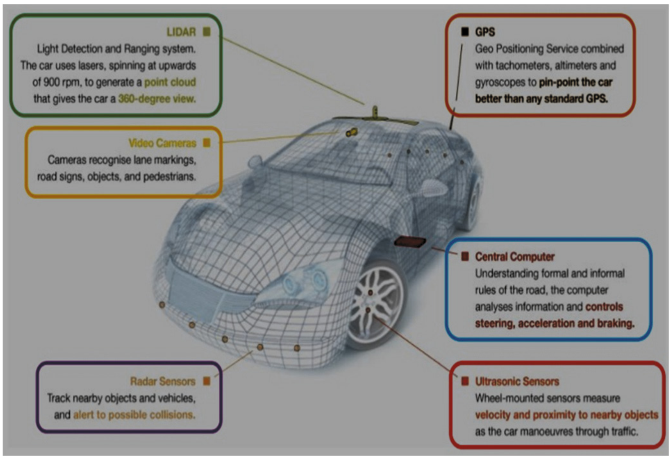

Fig. 1. On-Board Vision-based Sensors in Autonomous Vehicles [2]

Therefore, sharing the collected data with other vehicles via V2V Communication is vital for road and public safety. It is found that the driver's visibility varies from 0.1km up to 1km in foggy weather conditions [3]. Consequently, the inclement weather conditions should be communicated to nearby drivers within this visibility range (0.1km-1km) for the sake of drivers' safety. Therefore, V2V messages are designed to support a communications range of approximately 0.3km, which is beyond the capabilities of the on-board short-range sensor systems. Different technologies such as Dedicated Short Range Communication (DSRC) or Millimeter Wave Vehicular Communication (MmWave) are needed for such kind of short communications range. Although DSRC is the technology of choice for V2V communications right now, authors in [4] argued that DSRC may not be an effective V2V communication solution to support high speed data rates for sensor generated raw data exchange among vehicles and therefore millimeter wave (mmWave) communication will be a viable solution in the future.

Fig. 2. shows that V2V DSRC based communications technology can communicate various Advanced Driver Assistance Services (ADAS) such as car crashes or collisions at a rate of 1,000 messages per second, which is much earlier than the short range sensors [5, 6, 7]. Therefore, it is essential for the short range communication technologies (Radars, camera system and LIDARs) to be augmented with the V2V communications technologies (DSRC or Mmwave) to provide an effective information dissemination solution rather than using either approach alone.