Detection Method in External Communication for Self-Driving Vehicles Based on TDMA

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Agenda

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Research Objective

The proposed system is a flexible communication system that is able to communicate between moving license vehicles and to main center considering any obstacle may appear in the environment. This communication system is designed applying (TDMA) technique.

Introduction

Modern cars have touch screens, voice commands, With a number of functions through the mobile phone, in addition to the modern cars to replace the key with the start button, and became the automotive systems rely on the electrical system helps in its work, and not rely entirely on fuel, and thus help to provide the Fuel consumption will be significantly reduced.

Road Safety

The World's Road Safety Report 2015, which reflects information from 180 countries, indicated that the total number of deaths in road accidents has reached 1.25 million per year, and that the road mortality rates are the highest in low income developing countries. Most of the accidents that lead to death are due to safety belts, drunk driving, high speed, motorcycle helmets and safety systems for children, this means that the main cause of accidents is human. Therefore, resorting to the adoption of many technical methods to control these causes and reduce them as possible.

Driver-Less Car

The ideas of the driver-less car appeared due to more than ten years ago and that the project Google 2009 was the first launch of those ideas. Autonomous vehicles try to replace humans by driving automation to reduce the number of accidents on the roads due to human error. Autonomous vehicles use ad hoc networks, in vehicular ad hoc networks (VANET). These networks allow a more flexible and flexible communication between vehicles in the radio coverage area.

Many expectation realize that self-driving vehicles will be ready on the road by 2020.

powerful benefits of self-driving vehicle
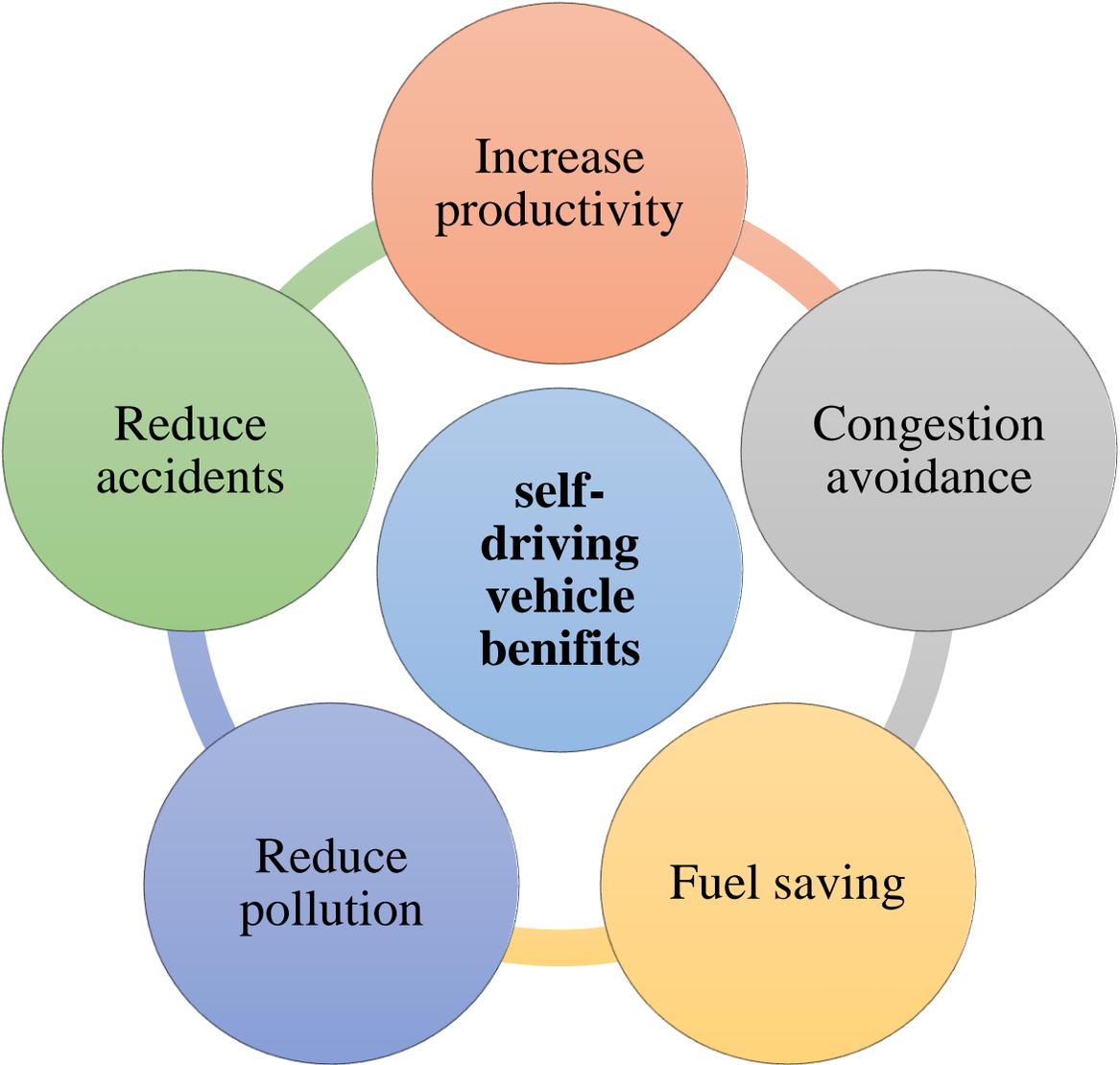
Multiple Access Techniques

Multiplexing is the process of combining multiple signals and transmitting that in a common channel. Then multiple access is the technique that used to allow multiple users to communicate over a single common channel. There are many types multiple access techniques, that here will be reviewed some of these techniques such as frequency division multiple access (FDMA), time division multiple access (TDMA) and code division multiple access (CDMA)

Multiple Access Techniques

- FDMA provides chunks of frequency spectrum to be used for data transmission. The data is generated at base band and modulated at varying radio frequencies.

- TDMA allows multiple user to share a common frequency band by allocating different time slots. Signals coming from each user will be transmitted at intervals depends on multiplying number channels into time slot.

- CDMA is a technique in which the data bits are modulated by high frequency orthogonal sequence of bits such as gold code. These codes are used to spread the signals over a large frequency band.

Time Division Multiple Access Technique

TDMA is used to control channel access between vehicles by sharing medium communication based on splat signal between nodes in that zone. It divides the signal between users' by allocating different time slots. In our research, we design intrusion on clustering head (CH) vehicles. The security system uses the TDMA cluster-based media access control to secure the external communication for self-driving and semi self-driving cars. To achieve stability and channel utilization, the cluster is needed in VANETs. The TDMA divides signal into time frames and it divides the time frame into time slots, where each vehicle is associated with time slot in the frame.

Features of TDMA

1. In case of TDMA a single carrier frequency is shared among several users. and each user use the time slots. The time slots used by the users depends on several factors such as modulation techniques and the available bandwidth.

2. Data Transmission in the case of the users of TDMA is not continuous but it occurs in bursts which results in low use of the battery consumption because the subscriber is turned off , when it is not in the use.

3. The Handoff process is much simpler in the case of TDMA because of its discontinuity and it is able to listen to the other base stations during its idle slot time.

4. The Transmission rates are very high in the case of TDMA as compared to the FDMA because of the Adaptive Equalization which is necessary in the case of TDMA.

Features of TDMA

5. The guard time present in the case of TDMA should be minimum.

6. The main advantage of TDMA is that it is very cost-effective technology which is used for upgrading a current analog system to digital.

7. In this the battery used is of extended life and the talk time , since the mobile is only transmitting the portion of the time of the time during conversations.

8. TDMA technology is used to separate users in time and ensure that there will not be any interference which is presented from any other simultaneous transmissions.

Time Division Multiple Access Technique

General Frame and Time Slot Structure in TDMA Systems
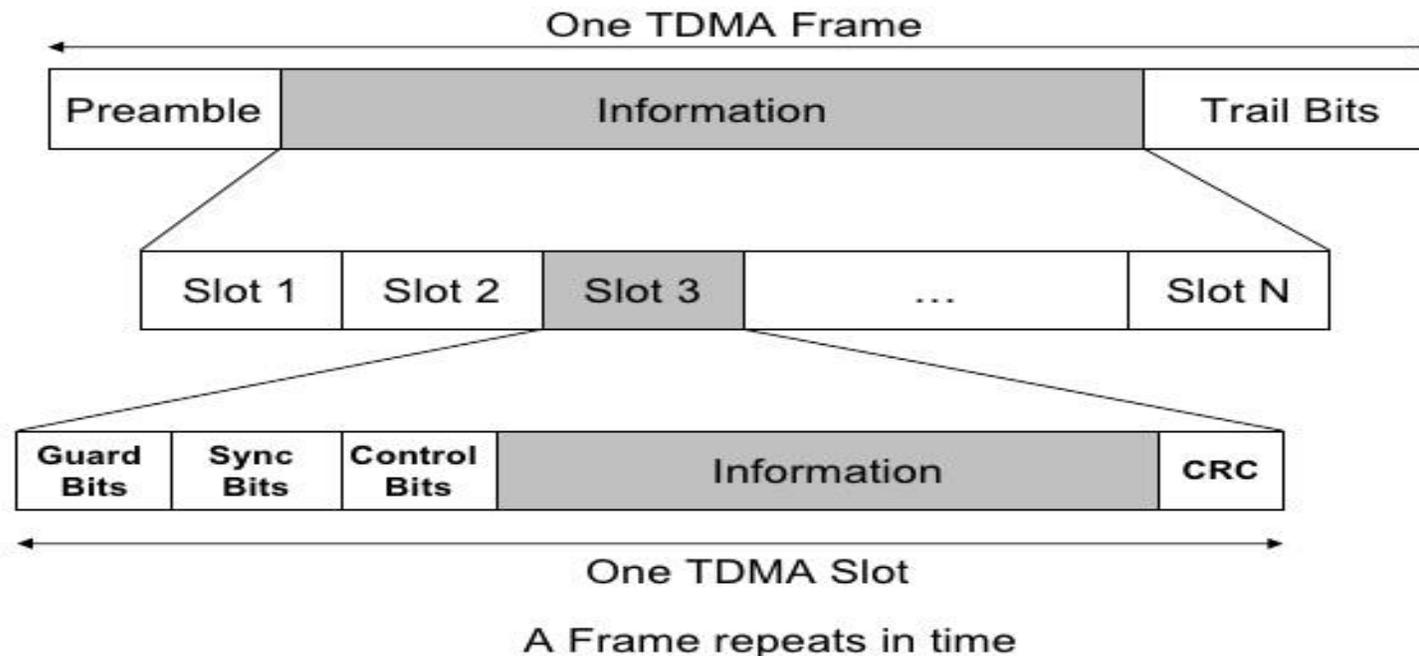
A TDMA Frame

- Preamble contains address and synchronization info to identify base station and mobiles to each other

- Guard times are used to allow synchronization of the receivers between different slots and frames
  - Different mobiles may have different propagation delays to a base station because of different distances.

Time Division Multiple Access Technique

Efficiency of a Frame/TDMA-System

- Each frame contains overhead bits and data bits.
  - Efficiency of frame is defined as the percentage of data (information) bits to the total frame size in bits.

$$efficiency = \eta_f = (1 - \frac{b_{OH}}{b_T}) \times 100\%$$

$$b_T = T_f \times R$$

b_T: total number of bits in a frame

T_f: frame duration (seconds)

b_{OH}: number of overhead bits

Number of channels in a TDMA cell: $N = m \dfrac{(B_{tot} - 2B_{guard})}{B_c}$

m: maximum number of TDMA users supported in a radio channel

Features of TDMA

- Enables the sharing of a single radio channel among N users
- Requires high data-rate per radio channel to support N users simultaneously.
  - High data-rate on a radio channel with fixed bandwidth requires adaptive equalizers to be used in multipath environments (remember the RSM delay spread σ parameter)
- Transmission occurs in bursts (not continues)
  - Enables power saving by going to sleep modes in unrelated slots
  - Discontinues transmission also enables mobile assisted handoff
- Requires synchronization of the receivers.
  - Need guard bits, sync bits. →large overhead per slot.
- Allocation of slots to mobile users should not be uniform.
  - It may depend on the traffic requirement of mobiles.
  - This brings extra flexibility and efficiency compared to FDMA systems.

Capacity of TDMA Systems

- Capacity can be expressed as
  - <u>System Capacity</u> (the capacity of the overall system covering a region)
    - × *Depends on:*
      - ꞯ Range of cells
      - ꞯ Whether the system can support macro-cells, micro-cells or pico-cells.
  - <u>Cell Capacity</u>
    - × *Depends on the radio link performance between a base-station and mobiles:*
      - ꞯ The lowest C/I (carrier-to-interence) ratio the system can operate for example quality of transmission. This in turn depends on the speech coding technique, desired speech quality, etc.
      - ꞯ Data-rate over the channel which depends <u>modulation efficiency</u> (bits_per_second/Hz) and <u>channel bandwidth</u>.
      - ꞯ The frequency re-use factor

Time Division Multiple Access Technique

Number of Channels in TDMA System

- Number of Channels is Total Number of Slots Multiplied by the Channels Available

$$N = \frac{m\,(B_{tot} - 2B_{guard})}{B_c}$$

Example 9.3

- The number of channel

$$N = \frac{B_t - 2\,B guard}{B_c}$$

- B_t = Total Spectrum Allocation
- B_{guard} = guard band
- B_c = Channel BW

em: TDMA/FDD

25 MHz, which is segmented into 200 speech channels are supported on a single

simultaneous users

ınd

$= 8* 25 *10\text{^}3/200*10\text{^}3 = 1000$

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Intrusion Detection System (IDS)- Seven Steps

1. **Generate the highway mobility** - and the output files of this stage are considered input files to NS-2.

2. **Network Simulator 2** - cluster members (CMs) will take information from other vehicles. They can generate a routing table for each vehicle. Each vehicle will broadcast 3-10 packets/second.

3. **Distance and angle calculation**- calculate distance and angle between vehicles based on values of X-axis and Y-axis.

4. **Detection phase** - the IDS on CMs has ability to detect the attacks from parameters that have been extracted from the routing table and trace file.

Intrusion Detection System (IDS)- Seven Steps

5. **CMs** - The IDS on CMs will send notification to CH when it detects malicious behavior. It sends warning message with full details about the malicious vehicle that is detected in clustering mode.

6. **Reaction of CHs** - The CH will generate alarms and blocking the malicious vehicle to alert other vehicles in inter-clustering and it send the same warning message to all CHs and RSUs in that zone.

7. **Performance metrics** - In this stage, we need to evaluate the proposed IDS by calculating the performance metrics such as the packet delay rate, (PDR) and throughput.

Implemented System
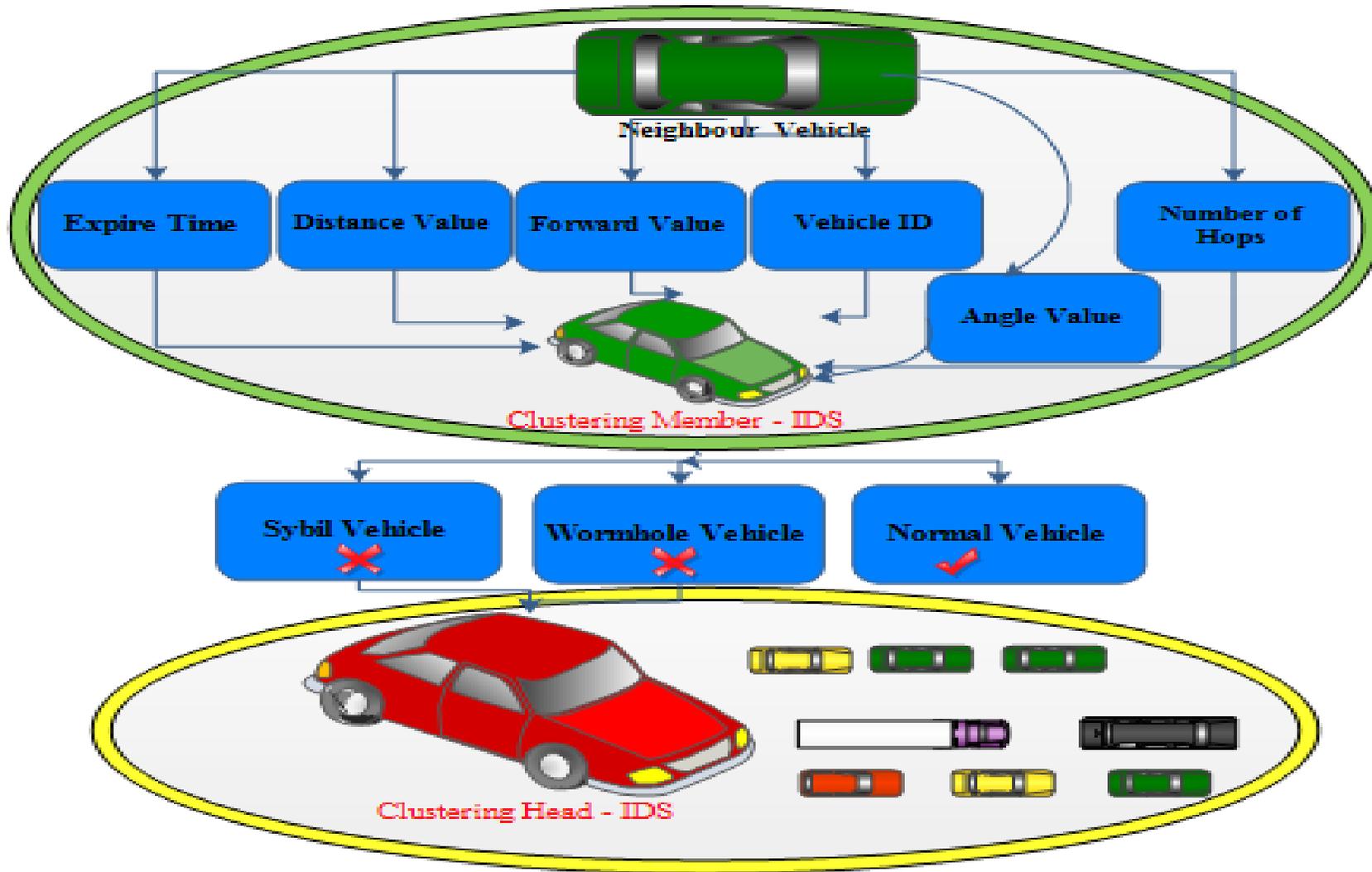
Simulated Results

Time	Parameters	V_1	V_2	V_3	V_4	V_2
T_0	Vehicle -ID	V_0	V_1	$V_{wormhole}$	V_5	V_{9_Sybil}
	Distance Value	64.6m	97.7m	130m	67.2m	97.7m
	Angle Value	-50.6°	-30.7°	-21°	-48.01°	-30.7°
	Time Stamp	7s	7s	7s	7s	7s
	Forward Value	1	3	2	1	3
	Number of hops	1	2	1	3	2
T_1	Vehicle –ID	$V_{wormhole}$	V_1	V_4	V_5	V_{8_Sybil}
	Distance Value	86.8m	139.2m	139m	107.3m	139.2m
	Angle Value	-35.1°	-21.03°	-21°	-27.7°	-21.03°
	Time Stamp	10s	10s	10s	10s	10s
	Forward Value	1	5	3	11	5
	Number of hops	1	3	5	3	3
T_2	Vehicle –ID	V_0	V_1	V_4	V_5	V_{6_Sybil}
	Distance Value	126.3m	139m	139.2	111.8m	139m
	Angle Value	-23.3°	-21°	-21°	-26.5°	-21°
	Time Stamp	16s	16s	16s	16s	16s
	Forward Value	1	10	8	12	8
	Number of hops	1	2	3	5	4

Simulated Results

We calculated the average classification rate of two types of attacks targeting self-driving vehicles in VANETs. Our findings are given in Table

	Accuracy	Class
IDS -Clustering	72.05%	Normal
	92.2%	Abnormal

PLOS ONE Journal (Q1)

RESEARCH ARTICLE

A hierarchical detection method in external communication for self-driving vehicles based on TDMA

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Abstract

Security is considered a major challenge for self-driving and semi self-driving vehicles. These vehicles depend heavily on communications to predict and sense their external envi-

- Synchronous = Multiplexer allocates exactly the same time slot to each device at all times
- in contrast, in ASynchronous TDM if the device have nothing to transmit then its time slot is allocated to another device.