

# Ingenious vehicular system to evade collisions

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## Abstract

Driver's response is indispensable in the aversion of collisions and in stringent circumstances. WiB-IVS (Wireless Broadcast Intelligent Vehicular System) is a proposed design for Intelligent Vehicular Systems enabling Vehicle to Infrastructure (V2I) communication for effectuating an interconnected network of vehicles for easier and faster information sharing in order to prevent collisions. The system centralizes on driver's response and thus aims to bring extrinsic information to the driver, stimulating situational awareness. An indication system fulfils this purpose and helps the driver respond to the scenario ahead. Information transmission is facilitated by communication between vehicle and broadcasting station based on User Datagram Protocol (UDP). The design approach caters to the problems of the collision at sharp or blind turns, offsite intersections and those occurring due to low visibility in extreme weather conditions such as fog. A pilot model design to test for the effectiveness of the proposed system architecture is also put forth in this paper. The pilot test results confirm the system's rapid response and its key potential for the future.

**Keywords:** Offsite Intersections; WiB-IVS; Intelligent Vehicular System; Vehicle to Infrastructure (V2I); Extrinsic Information; Pilot System.

## 1. Introduction

Collision avoidance has become one of the major issue and key area of focus for automotive industries. World Health Organization defines Road traffic injuries as a "major but neglected global public health problem". According to a report published by the W.H.O in 2013, a standard for road safety measures from 2011-2020, about 1.25 million people die each year as a result of road traffic crashes [1]. With several approaches towards the problems in terms of: Automatic Braking System [2], RADAR Systems [3] [4] for identification of vehicles ahead, LASER sensor based designs [5] to alert the driver of an approaching vehicle, GPS based systems [6] [7] [8], wireless communication amongst vehicles or Vehicle to Vehicle communication (V2V) [2] [9] [10] has emerged as the most promising approach. However, V2V establishes complex communication networks with complicated algorithms and calculations [11] [12] which are time consuming and difficult to realize. Moreover, there is the issue of anonymity of vehicles making it tougher to extract more information in short time. Hence another approach towards this problem is the use of Vehicle to Infrastructure (V2I) communication [13]. This approach utilizes an intermediary, generally a stationary structure, which helps in establishing connection amongst vehicles. The proposed system works on this very basic idea.

In another study conducted by National Statistics of road traffic accidents in India (2011) found drivers to be the main reason behind accidents [14]. Therefore, when designing an intelligent vehicle system, human factors such as the psychomotor, perceptual and cognitive skills of the driver should be taken into account because his reflexes during the act of collision may give him better chances of survival than the hardcoded system. Therefore, the system design proposed principally focuses on the driver response such that the driver is made aware of the situation with the help of an indicative system rather than an alarming system, which could trigger a brake response even when it was not necessary.

To enable understanding of the proposed system in a clear aspect, the paper has been divided into five sections. Section II describes the proposed WiB-IVS System and its associated components. A scenario depicting the manner in which collision is averted using the proposed system is put forth in Section III. A prototype pilot model developed is described in Section IV and was tested for scenario described in III. The results obtained from testing at small level have been further discussed along with the future applications and scope of the technology.

## 2. Overview of WiB-IVS system

The principal concept of WiB-IVS System is to establish communication between vehicles with the help of an infrastructure, capable of creating a mobile ad-hoc network broadcasting at frequencies to which vehicles respond. The goal here is to facilitate communication without the use of complex network topology and time consuming protocols. The vehicles must be able to share data via infrastructure within stipulated time for the driver to respond to the situation. In case of sharp or blind turns the time to create situational awareness for a driver must be minimal. Normally it will take about 2 seconds for a driver to responds to an accident, therefore, if a vehicle moving with a speed of 120km/h the reaction distance is about 80m. Coupled with the vehicle braking, coasting and other factors, the actual effective response distance is more than 100m [15]. On the other hand, with an impact of extreme weather conditions on the highway, such as fog, rain, snow etc. it would be more likely to lead to serious traffic accidents.

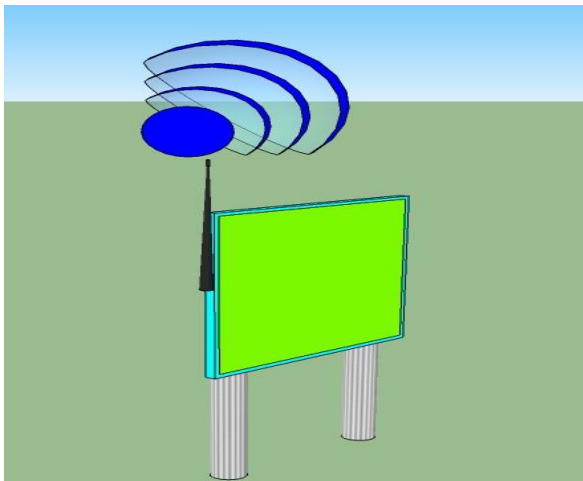


Fig. 1: Schematic for WIB-IVS Broadcasting Station.

As clearly evident from the system architecture, depicted by the schematics designed by the author in an open source software Sketchup 3D, the system comprises of four components:

### 2.1. WiB-IVS broadcasting station

The center of communication between the vehicles, a static entity preferably located at sharp or offsite intersections/turns of an area as shown in Fig. 1. It is principally a broadcasting station which creates a Wi-Fi network and uses UDP Protocol. The station thus becomes a UDP server and has an assigned IP. This IP is pre-Configd for every station is used to identify its location. Moreover, it acts as a TCP client and connects to the internet for uploading data to a central database system. This communication between UDP Server and TCP Client takes place internally with the help of a microprocessor that stores the data received and decides which part of data is to be sent.

### 2.2. WiB-IVS on-board unit

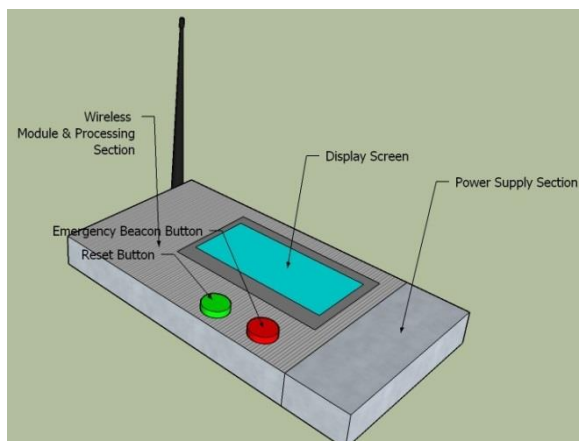


Fig. 2: Schematic for Wib-IVS On-Board Unit.

The vehicular equipment which communicates with the broadcasting station as depicted in Fig. 2. It stores the information about the vehicle type, vehicle's registration number, driving lane and travelling speed in a data packet. This unit acts as a UDP Client and is just conFigd to transmit and receive data from the station. The IP is pre-assigned for every vehicle, this helps in vehicle identification by cross referencing the IP with the data from the central server. Another major feature of the unit is E-Connect, which is an emergency beacon service triggered when the driver presses the button or in case of an accident. It Communicates a distress signal to the station which alerts and authorities that help the driver.

### 2.3. Caution index

The broadcasting station interchanges information about the travelling lane, type of vehicle and vehicle speed. This when received by the on-board unit, is displayed to the driver with the help of a LED indication system or Caution Index. It provides the driver with situational awareness and alerts him to make a decision to prevent a collision. The system is designed to alert the driver and not startle him as is done by buzzer or similar sound alarm systems. These types could trigger driver for applying brakes, typical response when suddenly distracted. Thus, it is purely a display system strategically designed to display both the vehicle type and approaching lane speed.

### 2.4. Central database system

It is very crucial that authorities have a record of vehicles passing by for security reasons. Moreover, in case of any calamity accessing the driver information could prove to be useful and hence the broadcasting station uploads all the data received onto a central database system. It keeps track of daily activities of traffic around the station and could help in traffic monitoring.

## 3. System illustration

A WiB-IVS Broadcasting Station employed at an offsite turn creates a Wi-Fi network for that area. A vehicle, SUV, approaching the radius of the station begins establishing the connection with the network by using SSID and key embedded in the on-board unit. Once connected the vehicle information is relayed to the station and is stored in the microprocessor. Now when another vehicle, Truck, is approaching from other side on the same lane it is unaware of the SUV due to an obstacle blocking the driver's view. It is known that higher the velocity of the vehicle more is the information received by the brain but this eventually reduces the driver's ability to assess the potential danger.

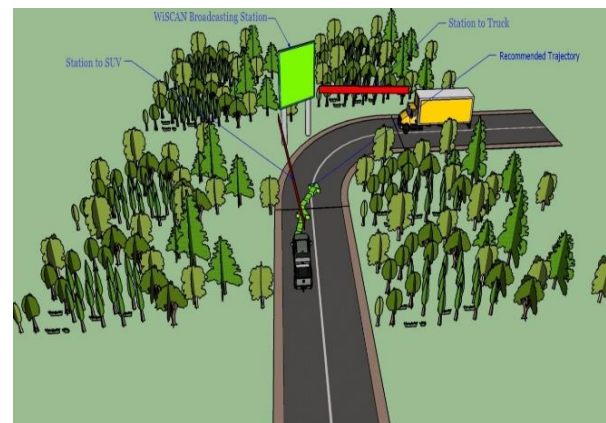


Fig. 3: Collision Avoidance Using Wib-IVS System.

So, as soon as truck connects to the station, it conveys the SUV's information to the on-board unit of the truck and truck's information to the SUV. Hence the drivers are made conscious of the approaching vehicle ahead. If both the vehicles decide to change the lane based on the information conveyed, situation remains unchanged and hence the station governs their trajectory, determined by vehicle size and its approaching speed. Since in this scenario the truck would require a larger turning radius therefore the station instructs the SUV's driver to change the lane. This information received by the on-board unit is displayed on Caution Index by illuminating the side to which the driver must turn. The intensity of illumination is red in case of heavy vehicles, blue in case of SUVs and green for cars and small commercial vehicles.

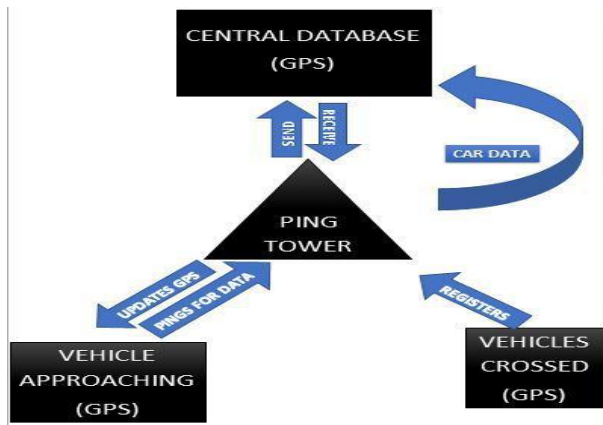


Fig. 4: System Architecture.

Thus, drivers acknowledge the station’s request and collision is averted using the WiB-IVS system as shown in Fig. 3. The system architecture and interconnection are represented in Fig.

### 4. Proof of concept

In order to test for the effectiveness of the above proposed system a pilot experiment was designed and is discussed below.

a) Components:

i). Free scale car chassis:

A rugged 1/18th scale car with steering controlled by Futaba servo motor (6V, 4.1 kg-cm) and is driven by TFC-Shield for FREE-SCALE KL-25z (fig. 5). The car chassis is powered by a 2S 1000mAh Lithium Polymer (Li-Po) battery. In further sections this will be referred to as ‘SUV’.

ii). Line follower robotic chassis:

A two wheel drive with omni wheel in the front for turning control (fig. 6). The car is controlled by a L293DE motor driver circuit actuated by Arduino Mega 2560. It will be referred to as a ‘Truck’ in further segments.

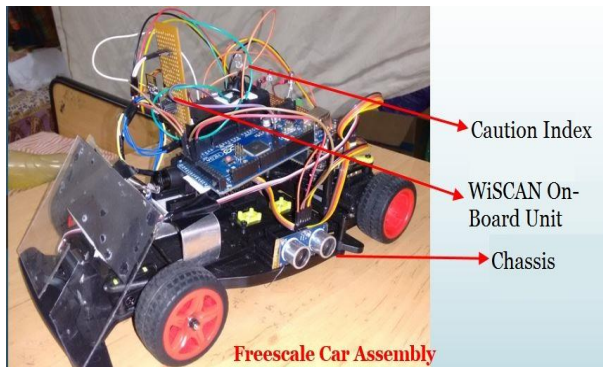


Fig. 5: SUV Employed for Pilot System.

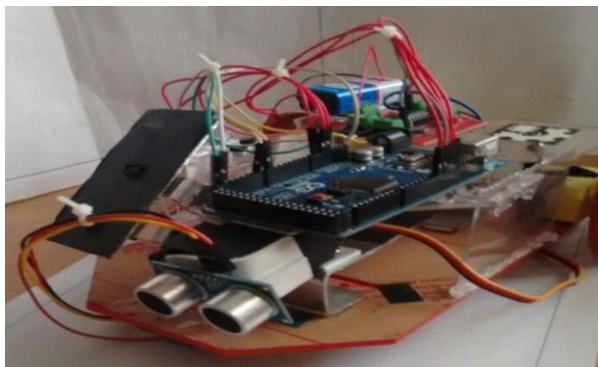


Fig. 6: Truck Employed for Pilot System.

iii). Wi-Fi Module:

A wireless transceiver module (ESP8266) with integrated TCP/IP Protocol stack with a maximum baud rate of 1.15 Mbps and is

used to setup WiB-IVS. Four such modules are employed, one of which is conFig as an UDP Server which creates an open Wi-Fi network ‘WiB-IVS’ with IP ‘192.168.4.1’. The server acts as WiB-IVS Broadcasting Station and is pre-conFig with a code to dictate the car to change its lane. The other two ESPs have been conFigd as UDP Clients ‘SUV’ and ‘Truck’ with IPs as ‘192.168.4.10’ and ‘192.168.4.11’ respectively. They act as WiB-IVS On-board Unit. A connectivity with internet for data upload on cloud is achieved by configuring the ESP as a TCP Server which connects to a mobile hotspot ‘WiSNET’. This communicates with UDP Server via serial communication achieved with the help of Arduino Mega 2560.



Fig. 7: Sample Data Uploaded on Cloud Server and Results from Things View App.

iv). Pilot Cloud Server:

An open source and API for Internet of Things created on thing-speak.com and used as a central database server to which initially a sample ultrasound data was logged represented in Fig. 7. When clients connect, the vehicular data is uploaded on a private channel named ‘ESP Trial’ which can be later checked in via the android app ‘Things View’. This establishes the ease of creating a central database system and that how its accessibility can be controlled even at pilot level.

b) Test Scenario

A scenario similar to that of a sharp turn was created for pilot test reference. WiB-IVS Broadcasting station was positioned on the turn, as it offers best connectivity and a broader range on both sides of the turn. A roadmap with a turn angle of 105° with truck and SUV approaching the turn on the same lane.

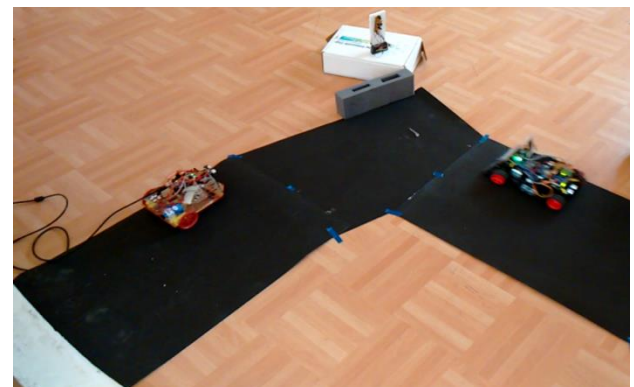


Fig. 8: Test Scenario, Both Vehicles Approaching the Intersection on Same Lane.

c) Testing

Testing of the pilot system was done in two phases: Static and dynamic. Initially static testing was performed with both the truck and SUV kept immobile and the ability of WiB-IVS On-board Unit being able to connect to Broadcasting Station accounted for,



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