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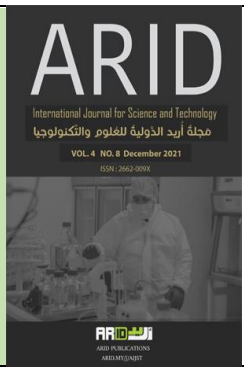

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Potential Using Vehicle to Vehicle Communication Based on Wireless Fidelity (Wi-Fi) for Supporting Intelligent Transportation Systems (ITS)

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إمكانية استخدام الاتصال من مركبة إلى مركبة (V2V) عن طريق تقنية wireless Fidelity (Wi-Fi) لدعم أنظمة النقل الذكي (ITS)

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Abstract

Vehicular Ad-hoc Network (VANET) becomes one of the most popular modern technologies these days, due to its contribution to the development and modernization of Intelligent Transportation Systems (ITS). The primary goal of these networks is to provide safety and comfort for drivers and passengers in roads. There are many types of VANET that are used in ITS, in this paper, we particularly focus on the Vehicle to Vehicle communication (V2V), which each vehicle can exchange information to inform drivers of other vehicles about the current state of the road flow, in the event of any emergency to avoid accidents, and reduce congestion on roads. We proposed V2V using Wi-Fi (wireless fidelity); the reason of its unique characteristics that distinguish it from other types. There are many difficulties and the challenges in implementing most types of V2V, and the reason is due to the lack of devices and equipment needed for real implementation. To prove the possibility of applying this type in real life, we made a prototype contains a modified toy car, a 12-volt power supply, sensors, visual, audible alarm, a visual "LED" devices, and finally a 12-volt DC relay unit. As a conclusion, the proposed implementation in spite of minimal requirements and use simple equipment, we have achieved the most important main objectives of the paper: preventing vehicles from collision, early warning, and avoiding congestion on the roads.

Keywords: Vehicle-to-Vehicle, Vehicular Ad-hoc networks, VANET, Intelligent Transportation System (ITS) .

الملخص:

أصبحت تقنية تخاطب المركبات مع بعضها البعض من أكثر التقنيات الحديثة انتشارا ورواجًا هذه الأيام؛ لمساهمتها في تطوير وتحديث أنظمة النقل الذكية (ITS)، وتعتبر هذه التقنية ذاتية التنظيم؛ حيث يتم إنشاؤها بين المركبات، أو بين المركبات والبنية التحتية. إن الهدف الأساسي من هذه الشبكات هو توفير السلامة والراحة للسائقين والركاب، وسوف يتم التركيز في هذه الورقة على النوع الذي يعني بتخاطب المركبات مع بعضها البعض Vehicle to .Vehicle Communication (V2V) حيث تقوم كل مركبة بتبادل المعلومات لإبلاغ سائقي المركبات الأخرى بالحالة الحالية للطريق أو في حالة حدوث أي طارئ؛ لتجنب الحوادث، وتقليلها، والحد من الازدحام على الطرق المختلفة. سيتم تسليط الضوء علي عملية تواصل المركبات باستخدام شبكة Wi-Fi (wireless fidelity) ؛ وذلك لما لها من خصائص فريدة تميزها على باقي الأنواع. من أهم المشاكل التي تناولتها الورقة هي الصعوبات والتحديات الكبيرة في تطبيق معظم أنوع V2V ، والسبب يعود إلى قلة وعدم توفر الامكانيات والمعدات اللازمة للتنفيذ الفعلي على أرض الواقع؛ لذا فإن الهدف الرئيسي من هذه الورقة هو إثبات أن V2V based on Wi-Fi هي الطريقة المناسبة والفعالة والقابلة للتطبيق داخل المجتمعات لا سيما الفقيرة منها. ولإثبات إمكانية تطبيق هذا النوع بأقل الإمكانيات قمنا بعمل مجسم يحتوى على مجموعة من المكونات التي تستخدم عادة في مجال التحكم الالي، وشبكات الحاسوب المتوفرة بشكل كبير، وأهم هذه العناصر: سيارة لعبة معدلة، وإمداد طاقة بجهد 12 فولت، وأجهزة استشعار، ووحدات إنذار مرئي و مسموع، و "LED" مرئي وأخيرًا وحدة ترحيل التيار المستمر بجهد 12 فولت ، كل هذا من أجل إثبات أهمية تطبيق V2V داخل الطرق المختلفة؛ حيث كانت النتائج إيجابية أكثر من المتوقع، باستخدام معدات بسيطة، وإمكانيات محدودة استطعنا تطبيق أهم أهداف الورقة المتمثلة في منع المركبات من التصادم، والإنذار المبكر.

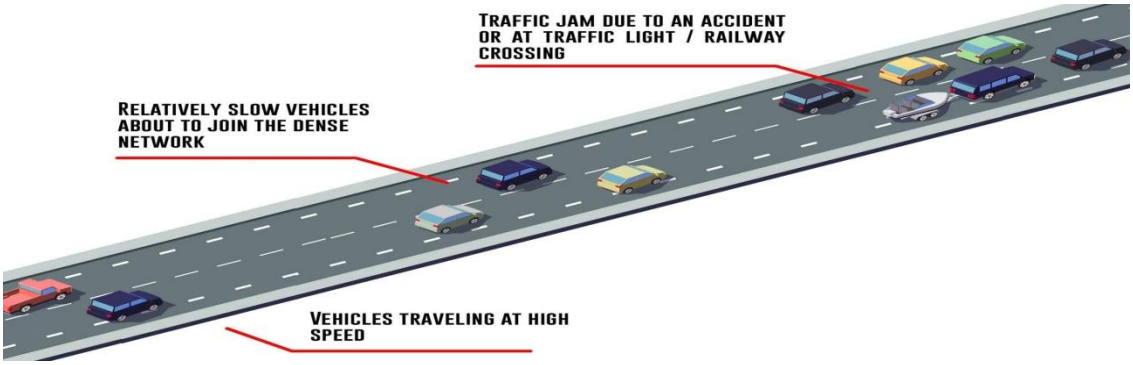
الكلمات المفتاحية:-

تخاطب العربة مع العربة، العربة مع كل شيء، العربات الذكية، أنظمة النقل الذكية.

1. Introduction

Vehicular Ad-hoc Networks VANET are designed to make the possibility of communicating different vehicles with each other. These days, networks have become the most important technology in Intelligent Transportation Systems (ITS). Safety issues in transportation are one of the main concerns, receiving much interest from both society and research communities. In the ITS field, VANETs emerge as an efficient. It can also be used to improve traffic management conditions in addition to reducing congestion and various road accidents. In addition, a VANET is characterized by its lack of a central coordinator, and thus a data or safety message may pass through multiple intermediate vehicles during its transmission from the source vehicle to the destination vehicle[1]. It is a self-organizing network that is established between vehicles together, or between vehicles and infrastructure. The smart city the best environment to apply ITS based on V2V communication, where it has a good infrastructure with artificial intelligence components for the communication process between V2V Communication. There are many applications for V2V communication; such as use Internet of Things (IoT), Light Fidelity(Li-FI), and Wireless communication technologies. In this paper, we focused on V2V using Wi-Fi; the reason of its unique characteristics that distinguish it from other types. V2V using Wi-Fi (wireless fidelity) has unique characteristics that distinguish it from other types. The most important of these characteristics are: flexibility, ease of use, low cost, and applicability. Building and maintaining a multi-hop routing route between the vehicles become much more complicated under these conditions. VANET node density corresponding to the number of vehicles sharing the route and the channel for wireless transmission of safety messages[2]. Each vehicle can exchange information with other vehicles to inform drivers about the current state of traffic tracking or the presence of a hazardous situation. Besides safety applications, VANET

also provides very important data to the road users like weather information, different paths cases, traffic around, preventing vehicles from collision, early warning, and avoiding congestion on the roads. VANET is an available network where each vehicle is permitted to join the network. There are three main types of VANET, Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), and Infrastructure-to Infrastructure (I2I). There is no particular method, which can ensure the trustworthy nature of the vehicles. Therefore, security becomes One of the main problems as communication between nodes, where any node can transfer fake data and may cause significant harm to other vehicles. These networks are made of sensor nodes deployed in large areas. Figure 1 shows VANET overall work.



Figure(1): VANET overall work

2. Problem Statement

Road crashes and the damage they entail represent a serious issue and are one of the main causes of death[3], some statistics have shown that the majority of road accidents are due to human error and a lot of these accidents could have been avoided if the drivers had been warned at least half a second beforehand. Traffic congestion is a major issue in urban areas as well as on highways. Accidents caused the majority of the traffic congestion. It occurs for a variety of causes, including driver error, road accidents, road obstructions, environmental conditions, and

so on. As a result, vehicles are either at a standstill or going at a low speed, causing time to pass, and wasting a significant amount of fuel. There are difficulties and obstacles in implementing some types of V2V. One of these is a lack of devices and equipment required for real environment. In a vehicular network, the most important challenge is the exchange of reliable and correct data among nodes[4]. In some cases, a traffic jam may be fixed in a matter of hours, while in others, it may take several days. As a consequence, traffic congestion has a negative effect on the economy as well as the environment. As a result, many automotive companies are taking the initiative to find effective solutions for traffic management, even though congestion worsens the situation. The more serious the congestion, the longer it will take to clear until the root cause has been resolved. Knowing the traffic conditions on the road ahead would allow a driver to follow alternative routes, saving time, and fuel. In addition, passing another vehicle without giving it advance notice presents a major risk, which can result in catastrophic accidents. How to find that there is a V2V path between vehicles x and y that are communicating with each other using the cellular network[5].

The main aim of this paper is to improve road safety and reduce the number of accidents by using Wi-Fi and to prove the possibility of applying this type in real life. we have set the following objectives:

1- Highlight the importance of V2V communication based on Wi-Fi, which has a significant impact on reducing congestion and road accidents with the least tools, devices, and equipment.

2- Making inter-communication between the nodes to avoid accidents and journey comfort and safety.

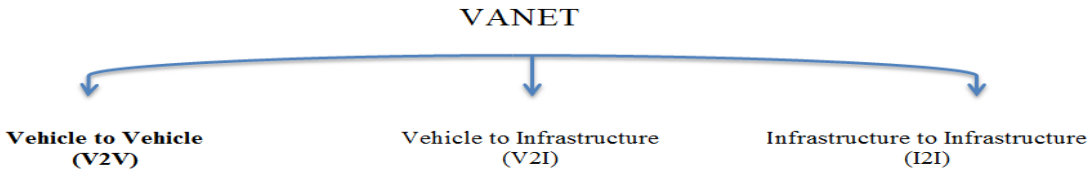
3- Providing vehicles with sensors to sense traffic if it is crowded, there is any obstruction on the road, accident, sudden break of the front car, or sudden pass without prior notice.

4- Identify and detect crowding, its location, intensity, and boundaries through lamps of different colors on the road or display them on the Application Unit.

5- Providing the vehicles with an external airbag in the event of any malfunction in the system, and no warning was given about the presence of a vehicle in the range and the approaching of the vehicle at a high speed causing it to collide with another vehicle.

3. VANET Overview

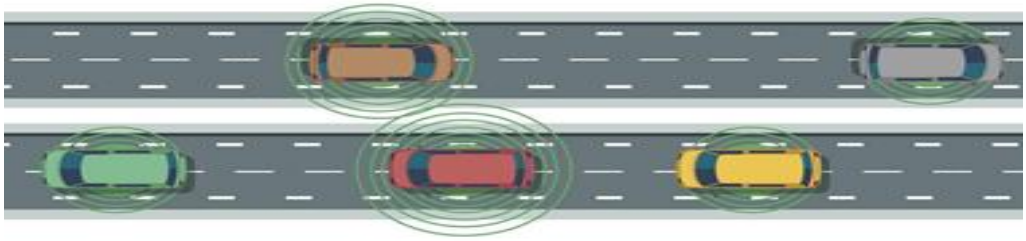
VANET is a subclass of Mobile Ad-hoc Network (MANET), which belongs to a family of Wireless Ad-hoc Network (WANET). Road congestion, traffic accidents, fuel consumption, and environmental pollution due to a large number of vehicles have become serious global issues. VANETs represent a crucial view of the ITS. Increasing the daily traffic represents a great challenge for the citizen of all urban and rural places[6]. There are three main types of VANET which include systems that provide for communication and information exchange by vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and infrastructure-to infrastructure (I2I) means[7]. figure 2 shows types of VANET



Figure(2): Types of VANET

4. VEHICLE-TO-VEHICLE (V2V)

Vehicle-to-vehicle (V2V) communications is a wireless network on which drivers send each other notices with information about their activities. This information will include things like speed, position, travel path, braking, and loss of stability. Technics such as brake lights, turn signals, and the horn allowed for greater understanding between drivers, resulting in safer and more organized roadways[8]. V2V technology uses dedicated short-range communications (DSRC), a standard set forth by bodies like FCC and ISO By creating a network of vehicles capable of communicating with each other. VANET comes to life, meaning that various transportation-related applications can be realized[9]. There are various aspects of the V2V charging problem that need to be taken into consideration before developing complete V2V solutions, such as, the users' privacy, data security, and the cost and profit models[10]. Figure 3 shows (V2V) communications.



Figure(3): (V2V) communications

5. Wireless Communication Technologies used for V2V

There are many types of wireless network technologies used in the process of communicating with V2V, the characteristics and features of each type differ from the other. Therefore, there is a strong desire for finding better wireless networking solutions to address the challenges in V2V communications[11]. These communication technologies are expected to increase traffic efficiency, road safety and provide comfort to passengers and drivers by providing both safety and non-safety applications[12]. Few of these technologies are discussed below:

6.1 Bluetooth (IEEE 802.15.1)

Bluetooth is a wireless technology standard used for exchanging data between fixed and mobile devices over short distances using short-wavelength. It uses a short-range wireless technology based on the IEEE 802.15.1 standard and operates in the industrial, scientific, and medical frequency band (2.4 GHz)[13]. Products that implement the Bluetooth specification can facilitate the automatic establishment of a connection between the car's hands-free system (typically part of its audio system) and a mobile phone.

6.2 ZigBee (IEEE 802.15.4):

Zigbee communication is specially built for control and sensor networks standard for Wireless Personal Area Networks (WPANs). It is a new low-cost, low-power wireless PAN standard, intended to meet the needs of sensors and control devices. However, the most unique features of the IEEE 802.15.4 standard are only obtained in the beacon-enabled mode[14].

6.3 UWB (IEEE 802.15.3a), or Ultra Wide Band

Ultra Wide Band (UWB) is a technology for the transmission of data using techniques, which cause a spreading of the radio energy over a very wide frequency band. UWB uses very low-powered, short-pulse radio signals to transfer data over a wide spectrum of frequencies that makes it tolerant to all types of disturbances. Recently, ultra wideband (UWB) has been used for radar or sensing in vehicular communications that play an essential role into operational areas in Smart Cities[15].

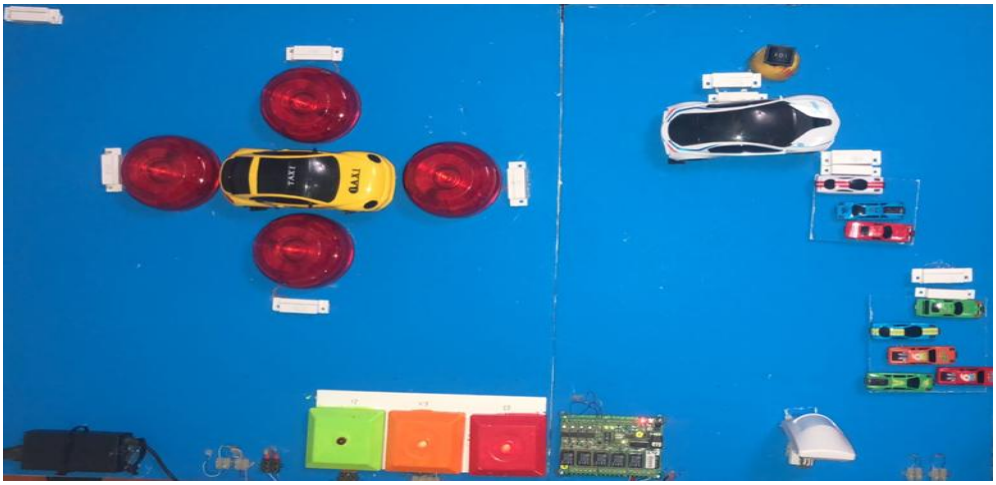
6.4 Wi-Fi (wireless fidelity)

Wireless network technology is considered one of the most important technologies used in the process of communicating with each other because it has great advantages of high flexibility, low cost, and ease of use. Wi-Fi is a wireless networking technology that allows devices to exchange information with one another. This is the general term for any type of IEEE 802.11 network. Examples of 802.11 networks are the 802.11a (up to 54 Mbps), 802.11b (up to 11 Mbps), and 802.11g (up to 54 Mbps). These networks are used as WLANs. Radio signals, router, and antenna are fundamental elements in wireless communications[16].

6.5 GPS Tracking V2V System

Global Positioning System (GPS) and route map provide a location of vehicles in VANETs. Every vehicle is provided by (GPS) device and Radio Frequency (RF)[17]. Location information can be used to find a route from a source to the destination for propagating a message. GPS Tracking V2V is a powerful, high security, and high-performance vehicle-to-vehicle GPS tracking system. It uses a tablet PC or Laptop plus a RF or GSM/GPRS modem to send, receive, and display location data of vehicles of a small group.

To demonstrate the possibility of implementing V2V based on Wi-Fi to increase vehicle safety, also to decrease the effect of traffic. we made a prototype carried out different experiments as shown below in figure 4. A complete experimental material and work have been provided and carried out including modified Toy Vehicle, 12V Dc Power supply, Sensors, Visual/Audible Alarm units, Visual "LED" devices, Cables, Switches, and finally 12V DC Relay module. Dedicated short-range communications (DSRC), a standard developed by the FCC and ISO, is used in vehicle-to-vehicle communication. Since one of the potential frequencies is 5.9GHz, which is used for Wi-Fi, it's also called a Wi-Fi network. At highway speeds, the range is up to 300 meters (1000 feet) or around 10 seconds. V2V would be a mesh network, meaning every node (car, smart traffic signal, etc.) could send, capture and retransmit signals.



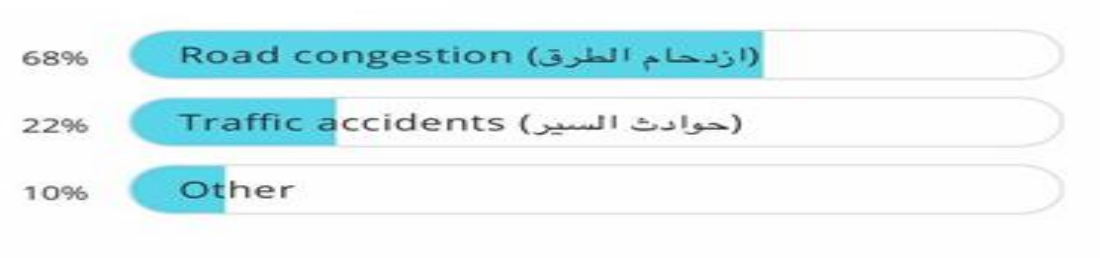
Figure(4): The laboratory prototype

6. Results and Discussion

To obtain useful data, a questionnaire was presented to people interested in road accidents and set of questions were asked related to the roads problems. After collecting and analyzing questionnaire data, the results for each question were presented as a percentage. The questions were as follows:

What is the most problem you face in the traffic?

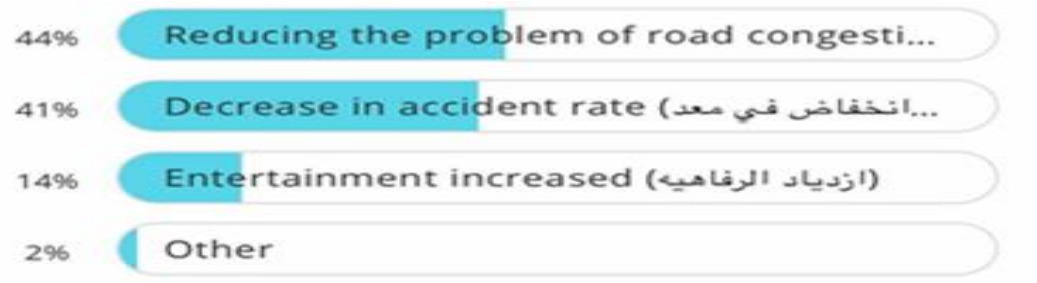
In this question, it was allowed to choose more than one an answer, and through analyzing the results, 68% of the sample faced problems of road congestion, 22% "Traffic accidents", and 10% other causes.



Figure(5): The most problems in the traffic

In your opinion, if we implement V2V systems in smart cities, what are the most important benefits it will provide?

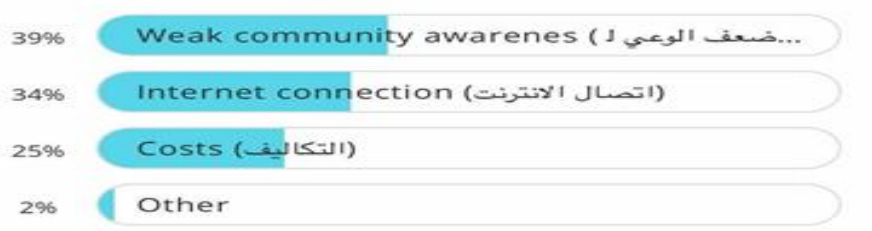
In this question, it was allowed to choose more than one an answer, 44% of the sample "Reducing the problem of road congestion", 41% "Decrease in the accident rate", 14% " Entertainment Increased ", and 2% "Other benefits".



Figure(6): Benefits V2V systems

In your opinion, if V2V technology is imposed on roads and vehicles in our country, what are the issues that will be faced?

In this question, it was allowed to choose more than one an answer, The survey was conducted based on people's opinions about issues in the implementation of roads for V2V systems in their city. 39% "weak community awareness", 34% "Internet connection", 25% "costs", and 2% "other ".



Figure(7): Implementation issues

7. Conclusion

This paper presented one of the emerging technologies that are still under study and development in the wireless network community. VANET received the attention of many researchers due to its unique nature. This Technology has great potential in facilitating road transport safety, and other vehicular communication applications, also VANET is to improve road safety as well as supports ITS. We have highlighted the importance of using V2V to provide safety and comfort

for drivers and passengers in roads. Data from the paper questionnaire is discussed, the most of the participants were agreed that use V2V can be used to improve traffic management conditions, reducing congestion, and road accidents especially in ITS. we proposed using V2V base on Wi-Fi; the reason of its unique characteristics that distinguish it from other types. To prove the possibility of applying this type in real life, We made a prototype contains simple devices usually used in the automatic control and a wireless network, such as sensors, visual, audible alarm, visual "LED" devices, and finally a 12-volt DC relay unit. The results were very motivating, we have achieved the most important main objectives of the paper: preventing vehicles from collisions, early warning, and avoiding congestion on the roads.

List of Abbreviation

DSRC	Dedicated short-range communications
GPS	Global Position System
ITS	Intelligent Transportation Systems
I2I	Infrastructure to Infrastructure
LED	Light Emitting Diode
MANET	Mobile Ad-hoc Network7
RF	Radio Frequency
UWB	Ultra Wide Band
VANET	Vehicular Ad-hoc Network
V2V	Vehicle-to-vehicle
WPAN	Wireless Personal Area Networks
Wi-Fi	Wireless Fidelity

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