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A Review on IoT Technology in Modern Cars

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***Abstract*— Vehicles are being revolutionized by integrating modern computing and communication technologies in order to improve both user experience and driving safety. IoT devices that provide a potential entry point to the in-vehicle network .Users can connect their smart phones to their cars to for example use the car's speakers and microphones to make phone calls or read out various diagnostics data from the car such an engine speed and coolant temperature.Vehicle2Vehicle (V2V) is an emerging and fruitful area of research widely investigated in IoT and in the driverless setting, in particular.**

***Index Terms*— Internet of Vehicle (IoV), Internet of Things (IoT); Sensors; Wireless Sensor Network, IoT, connected Vehicles, cloud. IoT, simulation, smart cars, internet of things, vehicle simulation systems.**

I. Introduction

Internet of Things or IoT can be broadly defined as the interconnection of devices among each other and with the internet to upload process and provide services to the world thus bridging the gap between physical world and their representation in the information system.The massive development in the last decade of computational embedded-systems has contributed to the born of dynamic and powerful networks of physical devices aimed at collecting and exchanging data. These networks are well-known under the name of Internet of Things (IoT).A premier example that represents this concept is the Vehicle-to-Vehicle (V2V) automotive technology. Inertial Navigation Systems (INS). They use sensors like accelerometers, gyroscopes and compass to detect user location via dead reckoning, the process of calculating a position by using a previously determined one; Wireless Positioning Systems (WPS). They use wireless sensors to detect the most probable user location in a limited area using available networks information stored in a database. The expectation of experts is that by 2022, the market of IoT will reach 14.4 trillion dollars. The applications of IoT rule many domains transportation and connected vehicles. Connected vehicles refer to wireless connectivity between vehicles that can communicate with their internal as well as external environments. The supporting interactions in connected vehicles are: Vehicle to Sensor on board (V2S), Vehicle to Vehicle (V2V), Vehicle to Internet (V2I). The integration of IoT, connected vehicles and cloud will lead to a successful intelligent transportation system.

II. Background

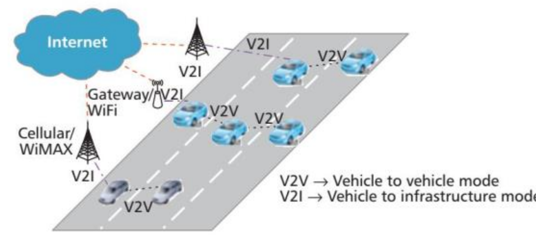

Fig. 1. Wireless vehicular networking

A. *Enabling Technologies*

The key enabling technologies are:

1. Security
2. Fog computing
3. Seamless, optimized connectivity, mobility
4. Deterministic networking (wired and wireless)

1) *Security*

In ITS secure connectivity is essential. Highly secure communication from car to wider network requires encryption. For on demand secure connectivity, strong firewall, intrusion prevention is required. For easy development and management, centralized identity and policy management with authentication, authorization, accounting is required

Fig. 2. Cyber security in modern vehicles

2) *Fog computing*

It is the edge of network computing. Many supporting techniques can be applied to cloud computing like virtualization, multi tenancy, IaaS, PaaS, SaaS and automation.

3) *Seamless, optimized connectivity, mobility*

It requires multiple wireless WAN interfaces like Wi-Fi, 3G/4G (LTE), highly scalable secure mobility and for seamless

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user experience, non-stop reliable connection management, application aware, flow based connectivity.

4) Deterministic networking

It can be either wired or wireless networking. The Key elements required are: Network synchronization, Timely transmission and Centralized scheduling. Wired networking requires time triggered Ethernet and wireless may use 802.15.4 for low power low rate (4Hz), and Wi-Fi (802.11ac) for higher rate (100Hz).

III. Simulation in IOT

Since the whole structure of IoT is pretty big, it is viable to use simulations to develop the applications and testing the business model around the proposed applications without having to invest in hardware until a mature model has been made. Thus, in the scenario of vehicle simulation is required to have a complete analysis of the data and the behavior of the simulated model in order to have safety precaution taken and the performances are optimized

A. Application of Simulated Iot for Vehicular System

It is straightforward to predict vehicles are a big center of attention of IoT applications since vehicles presently represent one of the largest technology expenditure/investment by any consumer. Vehicles are mostly complicated machines incorporating multiple micro-controllers communication via onboard buses. The different applications of IoT in vehicles can be:

1. Effective and safer driving methods that can prevent accidents and save lives.
2. It gives timely maintenance warnings, therefore, makes the mechanical performance safe.
3. Maintenance and operation cost is low.
4. Prior information about traffic and driver.
5. Vehicle to vehicle communication.
6. Vehicle to internet communication

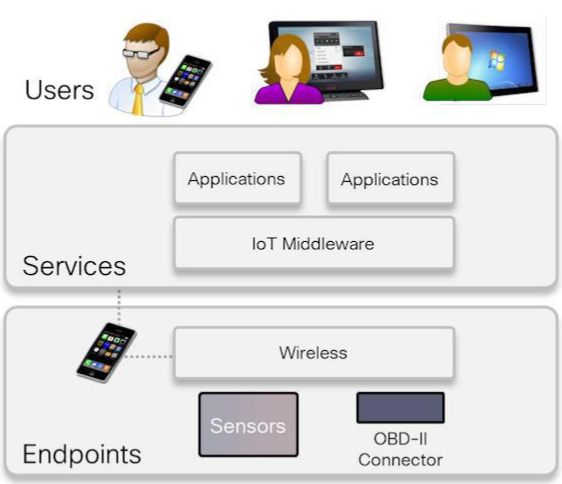

Fig. 4. Vehicle simulation setup.

IV. Deploying Security and Tracking Features in a Vehicle Using IoT

For the sake of simplicity and cross-platform implementation, we use Raspberry Pi with Linux based OS to handle computation in the chip. Other modules include GSM and GPS modules, door sensor, proximity sensor, PI camera, USB interface, and dongle interface. The 32-bit ARM-based controller functions fully as a CPU core.

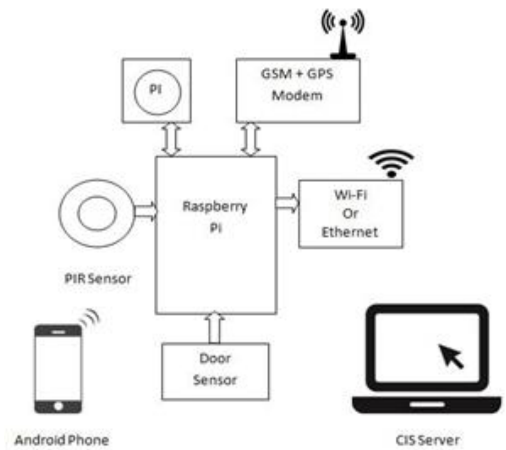

Fig. 3. IOT Car tracking system.

Device functionality programming is done in Python. The device initializations are completed during Power on Reset and wait for the Centre Locking Command to the car through the smartphone. The locking is handled through a GSM modem's SMS communication. Upon unauthorized opening of the door, the door lock sensors get actuated and proximity sensors detect human entry/motion inside the vehicle. When the vehicle has been stolen/mishandled, the driver is notified through an app and the person can activate the tracking system which will enable the camera and start tracking the GPS location. The camera captures the internal and external images of the car and the surrounding and sends it to the device. This can be obtained by rotating the camera behind the rearview mirror of the car.GPS Modem Questar G702-001UB co impact all-in-one is used for tracking and the location (latitudes and longitudes) [7] of the vehicle is periodically sent to the user email ID or CIS mail ID from the Raspberry Pi board. The modem device is ported to Renesas processor to avoid overflowing with continuous data frames. A simulated model can automatically activate the whole process using its previous knowledge analysed in the lab. These techniques can help bring smart cars into the consumer market at reasonable cost.

V. IOT Accident Management

At the present day, in the some gasoline engines are used port fuel injection system. This technique has achieved a high development point. As these engines operate with stoichiometric mixture, fuel economy and emissions of these engines cannot be improved further. However, GDI engines have been popular since these engines have potential for reduction of toxic, CO_2 emissions and fuel consumption to comply with stringent Environmental Protection Agency (EPA) standards (Spegar et al., 2009). To attain this potential, it is required that use of the GDI engines with supercharging and/or turbo charging (Stan, 2009). The GDI engines with turbo charger enable the production of smaller displacement engines, higher fuel efficiency, lower emission and higher power (Bandel et al., 2006). The GDI engines also help eliminate the disadvantages conventional turbocharged engines (namely turbo lag, poorer fuel economy and narrowed emissions potential) to provide viable engine solutions.

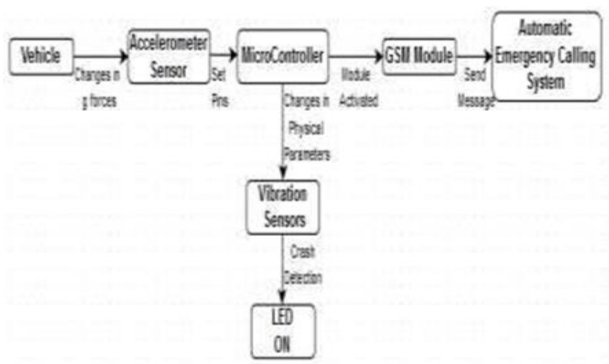

Fig. 5. Triggering emergency calling system

The model presented here is adaptable and thus it can be deployed anywhere. For instance, for a specific location i.e. on a road there are numerous vehicles traversing the road on different speeds going towards different destinations taking different routes. There is a high probability of accident between vehicles and the rigorousness of resulting loss can vary. Any accident is detected or accompanied by some kind of collision. By measuring the intensity of these collisions, we can detect how harsh the accident is. For example, if a smaller collision is detected we can easily judge that the vehicle has experienced just a small dent or puncture. Whereas on the other hand, if the collision detected is of larger momentum then we can judge that a large amount of loss is incurred in terms of human lives as well as in terms of vehicle damage. Information about a major collision is thus sent to the cloud server which then becomes responsible for gathering help. In our model, the collision and its intensity are measured and the corresponding value is generated let it be z. The value of z is mapped on a scale ranging from 1 to 4. If the value of z is less than 2, we need not to inform the cloud server about it. We can easily inform the nearby sensors about the event thereby leveraging the concept of IoT to gather help. If the value of z is greater than 2, then we can assume that a major loss has occurred and a higher level help is required. The cloud server is informed about the collision where the database of cloud server is searched for appropriate people and the requests are generated to other helping agents like ambulance, car agency, hospital etc. The entire working is depicted pictorially in the following figure.

The model presented here involves a collective integration of different types of sensors as well as microcontroller units which acknowledge emergency calling system. . Accelerometer sensors and vibration sensors are collaborated. Accelerometer sensors measure proper acceleration and when at rest on the Earth's surface quantify an acceleration g=9.81 m/s2 straight upwards. Vibration sensors measure various physical parameters like changes in acceleration, temperature by converting them to electrical signal. During an accident, the changes in g-forces (acceleration) in the vehicle are sensed by the accelerometer sensors. The flags are set on a microcontroller which is a single integrated circuit. It represents the data by setting the appropriate pin of LED. Turned ON LED implies crash detection by vibration sensors. Therefore the microcontroller instructs the GSM modem and a message is sent to a predefined telephone number by the GSM modem.The estimate of g-forces measured by the accelerometer sensors can be used as a reference to be rated on a scale in order to provide an idea about the depth of the accident. For this purpose, the sensitivity of the accelerometers must be very high and must measure low level accelerations precisely from D.C. up to 50Hz (or above). Also, they must be installed with a high positional accuracy. Hence the accelerometer sensor module works as an important factor in detection of vehicle accident.

TABLE I
ACCIDENT DETECTION FOR VARYING VALUES OF G-FORCES

Accident severity	Value of z	Approximate value of G range
Safe level	1	0-4 g
Slight level	2	4-20 g
Moderate level	3	20-40 g
Critical level	4	40+ g

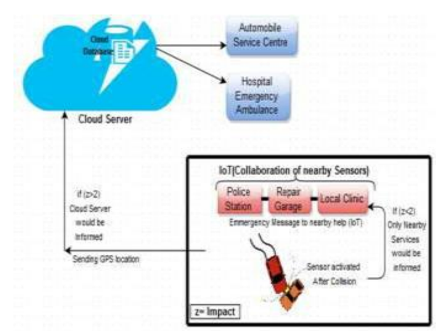

Fig. 6. Diagrammatic representation of the working of the system

VI. CONNECTED VEHICLES AND CHALLENGES

Vehicle communicating with outside world was started in 1996. So many sensors are used in connected vehicles to sense the physical properties. The main aim of the connected vehicles is to reduce traffic congestion, fuel consumption, to avoid accidents and to provide comfortable drive and road safety. For communication purpose short range signals are used on highways. If the connection is, vehicle to internal parts then local area network connection can be used. If the communication is between the vehicle to vehicle, vehicle to

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internet, vehicle to road, then Bluetooth (or) Wi-Fi (or) Zigbee are used. ¾ Bluetooth range is 100mts. ¾ Zigbee range is 50mts. ¾ Wi-Fi range is 32mts. ¾ Wi-max range is 30miles. Wi MAX is advanced technology still not used in vehicle communication. The information like speed and position of vehicle data can be transferred between the vehicles on Ad.hoc mesh network. They are some major problems and challenges in connected vehicles.

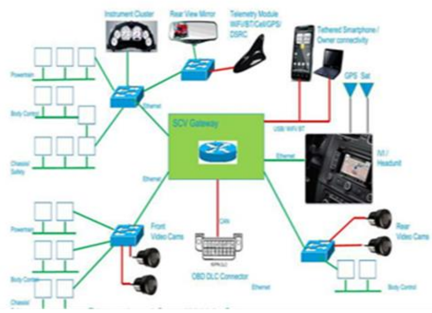

Fig. 7. It represents integrated future vehicle network

The scenario of future vehicle network integrated with IoT and cloud can be viewed as shown in Fig. 2. It will contain the following: x Ethernet-based Central Vehicle Gateway. x Mini-switches/hubs aggregate ECUs/Sensors depending on location within vehicle x Potential reduction in wiring harness density and bus splices.

Problems:

1. There is a loss of data at unconnected huge vehicles comes between the connected vehicles, and at building intersections.
2. Because of more moving vehicles there an occurrence of Doppler effects, shadows and multiple path fading. 1865.
3. Due to the mobility of vehicles network topology changes very fast and frequently.
4. Sometimes data transferring disconnected because of small network range of vehicles communication, frequent change of network topology &high dynamic network topology.
5. The data link between the connected vehicles is interrupted due to obstacles.

Challenges:

1. Integrating the heterogeneous elements on IoT architectures in connecting vehicles is a big deal.
2. Smart devices integrating into an intelligent transportation system is another challenge.
3. The collected data from sensors should synchronize uniformly.
4. And there is need of cloud platform alternative to support the intelligent transportation system.

Research Directions:

1. Performance issues in connecting nearby vehicles through GSM/Wi-Fi/BLE/RFID.
2. Development of In-vehicle control algorithm to regulate the speed of the vehicle based on traffic updates.
3. Network discovery and device synchronization.
4. Speed limit may control by embedding the magnets in roads.
5. Self-texting cars may be introduced by taking voice commands from drivers & it converts as texting and also automatically responds for the incoming messages.
6. By studying the needs of consumers, new era begins that infotainment, which is a combination and information and entertainment in a connected vehicle is forefront.

VII. Conclusion and Future Scope

IoT has gained much attention from industry and researchers in recent years. It is a trend that will continue in future
In this paper, we have inherently proposed an intelligent accident detection and safety scheme from the integration of the hyped technology available today by saving the precious lives. Another important aspect, that is security, is discussed and a small introduction of how it can be implemented with ease in any modern day vehicle has been demonstrated. Such implementation has a varied scope and using technologies like RFID, Bluetooth,GPS and the use of sensors will help boost the research in this area and finally, smart cars will become commonplace in the days to come.

In this paper we presented Vehicle-2-Vehicle Elastic Network, which allows better positioning for cars using an inertial navigation system combined with a Vehicle-2-Vehicle technology.

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