Driver Profile and Smart Cars, A Step Ahead in Vehicle Registration and Security

Alexis O. Rosario Cruz
Master of Engineering in Computer Engineering
Advisor: Nelliud D. Torres Batista, DBA
Electrical and Computer Engineering & Computer Science Department
Polytechnic University of Puerto Rico

Abstract —*As vehicle technology advances, so will vehicle security. Systems are being developed to make all elements in a traffic environment communicate with each other to provide a safer and secure landscape. While such an implementation seems complex and years away, technology available today can be used and leveraged to start providing levels of security by way of enabling communication among vehicles. Implementation of such technology today can help solve many issues with regards to vehicle security, which is one of the most important assets in any home and are in a constant risk if not secured correctly.*

Key Terms — *Security, Software, Technology, Vehicle.*

INTRODUCTION

A technology wave has risen in the latest times in which objects in our homes become smart. With only voice commands we can be able to dim lights or turn then completely off, change radio stations and check if our water is running. Systems installed can alert us if any intrusion is detected on specific areas of our homes and a new initiative to make these smart objects communicate with each other has become a focal point for many developers. These smart object technologies can be put to good use once they learn how to communicate with each other.

Vehicles, on the other hand, are moving towards becoming aware of their environments. The objective at this moment is to detect any possible collision risk and alert the driver, as well as implementing certain mechanisms to prevent them from accidents; features mostly available during low speeds. Vehicles today also have the ability of detecting and aiding drivers on how to park. Some can even park perfectly by themselves by use and manipulation of cameras and sensors. In the future, vehicles are also intended to be made into smart objects. Self-driving cars, for examples, must have a technology that allows them to communicate with each other for decisions like lane changing or sudden stopping during normal maneuvering functionality.

Currently, our vehicles are mostly aware of themselves. Sensors indicate if any fault is present, and if that were the case, a highlighted symbol would represent where troubleshooting would be needed. This has become the standard to help maintain the functionality of a vehicle by making its driver aware of what kind of maintenance is required. However, new technology is being implemented each year to ensure that a vehicle becomes aware of their drivers (or, the devices they carry with them). This allows for personalization based on the driver's preferences during vehicle use.

For example, a driver may have a Bluetooth device that automatically connects to vehicle's radio, allowing music to stream or answering the phone hands free. The vehicle's configuration will also indicate which is the primary device to which it will connect, in the case that more than one person has a Bluetooth enabled device with them. This indicates a sign that a vehicle can be capable of being a smart object and even have the functionality to communicate with other devices that are available to its owner.

A VALUABLE ASSET

In Puerto Rico, cars are a very important part of our daily lives. Public transportation is not reliable island wide, with some areas having little to no options whatsoever that provide a means of moving from one point to another. This makes vehicles an essential asset in every home. Regular

maintenance can help extend a vehicles years before having to invest in another one; but mechanical problems are not the only risk to one of the most valuable assets a person can have.

Criminal activity is also a threat to the safety and security our vehicles provide. Theft and vandalism can happen at any moment to any person and, in most cases, tracking down the author of these type of crimes can prove to be difficult even with current safety mechanisms in place. Recovering from any of these types of crimes can also prove to be time consuming and affect any activities that require transportation; for example, being able to be present at work.

In Puerto Rico, the vehicle theft felony incidence has only decreased by 8 reported incidents by April 30th, 2019 as compared to the same date the year before. Even though a decrease of reported cases can be noted, the average per year remains close to the amount of 300 stolen vehicles.

Accidents can also happen when least expected due to a variety of circumstances - each with its own complications which put at risk the only asset many of us have as a means of transportation. Here lies the importance of vehicle insurance information. With an active insurance, a driver who causes an accident has insured amount for the damages caused to other property; which could include another driver who may incur on medical expenses resulting from an impact, a fence or any other impacted element that requires repair. As part of the local law in Puerto Rico, no vehicles are allowed to transit on public roads without an active insurance seal. This insurance seal renews on a yearly basis.

To combat vehicle theft, there are Automated License Plate Readers (ALPR's). These systems consist of camera readers which render a file image of license plates captured during the day and then compare image data with a database in which a vehicle may or may not be reported as stolen. ALPR systems are installed on patrol vehicles and they possess the ability to collect data as the vehicle drives around. There are times where a Police officer must first confirm a license plate number by means of a phone call to someone with access to the database to ensure accuracy of information for a vehicle. See Figure 1 below.
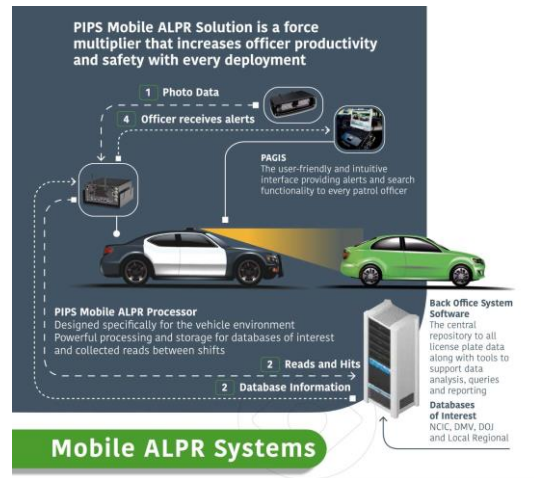
Figure 1
PIPS Mobile APLR Solution [1]

ALPR systems are consist of the following components: multiple mobile cameras, usually from 1 to 4 which can be Infrared (IR) or colored; a processor which can help support up to 4 installed cameras simultaneously on a police vehicle; brackets, which are required to mount the cameras and that conform to vehicle light bar designs and, software which provide the graphical user interface and application from within the vehicles as well as compare the images against required database systems to confirm if any of the captures license plates have a registered felony on the database.

This system, however, has some limitations. For example, a single ALPR camera can be able to read up to two license plates concurrently and they also depend on the speed at which the vehicles are moving. It is also possible that an ALPR cannot detect a stolen vehicle if the license plate has been cloned from another vehicle that is not registered as part of a felony. This due to the fact that the ALPR camera will snap a picture of what is visible to the camera at the moment. There is no easy way of knowing with certainty if the information presented and captured by the ALPR system has been previously manipulated.

Other issues with vehicles are that, by itself, it cannot provide information of its owner.

Paperwork and license plate confirmation can be done, but it would take time to do so. No identification is what can sometimes delay an investigation related to a missing person or a wanted felon.

Insurance information is another important factor when it comes to our vehicles. A seal is placed on the front windshield and this is an indicator that insurance for the current year is active and that any penalty fee has been paid. The seal is required and without it no vehicle can operate on our streets and highways; however, this seal has been copied and cloned to be placed on vehicles that do not have any insurance. In the case of an accident, any damage cost cannot be covered - and it is only at this moment where a cloned seal can be detected at times.

Although these types of infractions to the law may be alarming, new technology can be put to good use in paving the way for vehicle security. Current elements used to ensure a vehicle is compliant to law may be upgraded to diminish any felony related to vehicle security as well as provide a driver profile for its current owner and/or authorized drivers.

DRIVING FORWARD

Currently, testing for self-driving vehicles includes an upgrade that will allow vehicle to vehicle communication (V2V). While self-driving vehicles are far down the road, this type of communication can become quite resourceful today. V2V works wirelessly and it provides the ability of a vehicle to share data. This uses a Dedicated Short-Range Communication (DSRC) device which can send up to 10 messages per second [2].

DSRC is defined as an open-source protocol for wireless communication. It is compared WiFi due to its similarities. DSRC are intended for highly secure, high-speed communications between vehicles and the infrastructure surrounding them. The technology is low latency, which relates to the opening and closing of connections being very short. Additionally, this technology has limited interference and its performance is still considered strong during adverse weather conditions.

Since 2004, DSRC technology operates in a band that was dedicated by the FCC in the year 2004. They have separated 75 MHz of bandwidth at 5.9 GHz to be used for vehicle safety and other mobility applications. In this band many technologies and applications are currently developing applications related to vehicle communications and safety. The band is also eligible for use by non-public safety entities for commercial or private DSRC operations [3].

Many DSRC applications developed include:
- Transit signal priority.
- Transit vehicle refueling management.
- Personalized taxi dispatch services.
- Integrated transportation financial transactions.
- Enhanced truck roadside inspection.
- Pedestrian safety at intersections.
- Routing and scene management for emergency services.
- Advanced highway-rail and highway-transit grade crossings.

With this type of communication, drivers can be alerted of their surroundings and driving can be made safer. All the data the car collects needs to be analyzed to determine the best course of action. This is the main function of the control algorithms and software. This is the most complex part of the self-driving car since it has to make decisions flawlessly [4].
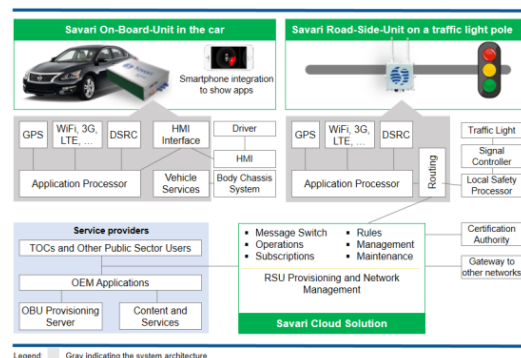
Figure 2
Savari System Architecture [5]

Companies like Savari and SAIC Motors have partnered on V2X (vehicle to many communication) technology, with the purpose of testing V2V, Vehicle to Pedestrians (V2P) and Vehicle to Infrastructure (V2I). Figure 2 illustrates the Savari V2X System Architecture.

It could be possible to start implementing DSRC technology to enable vehicles to have driver profiles and provide information about themselves and their insurance. For implementation, vehicles can send information to patrol vehicles which could have devices that can receive, and decrypt information sent from a vehicle with the DSRC. Since only information will be transmitted from a civilian's vehicle, the device with DSRC can be made similar to the current insurance seal placed on the front windshield. This can be referred to as the DSRC Driver Profile System.

The information to be transmitted by the DSRC vehicle will include Vehicle Owner, Owner License Number, Vehicle License Plate and Flag Codes, if applicable. Information should be encrypted and only decrypting by the device receiving the information; commonly the police vehicle. Software specific to decoding the flag messages will alert police vehicles when a vehicle has a registered felony or does not have updated insurance information. Information decoded will inform who owns the vehicle and their current license number for identification.

The DSRC Driver Profile System will consist of an Insurance Seal; installed at the windshield of the driver. This will be the data transmitter. There will also be a receiver, which will be installed into police vehicles. The receiver will decrypt the information and will provide alert when a flagged vehicle is near. Software will help setup the information and store it in the database. The software will be used to store information in the database, render received data file into readable text and will provide information to the vehicle owner as well as provide the option to report a vehicle and flag the information sent by the Insurance Seal.

Users can edit driver profile when a vehicle is initially purchased or re-sold. A driver profile will directly link drivers to the vehicle or vehicles they own. While setting up a driver profile they would also be able to list any authorized drivers for a vehicle (which need to be included in the vehicle insurance) which will aid any law enforcement agent in a situation in which they must inspect a vehicle that is not being driven by the current listed owner. They can also set up a flagged message in the case the vehicle is missing or has been become the object of a felony. User access will be restricted; they can only set up their own profile and flag vehicle information. No editing of license plate or any other essential information will be allowed to a general user of this technology. This type of information will only be modified by users who are allowed to distribute and manage vehicle information, according to local laws and regulations.

The software itself will create a text file in which the data to be transmitted will be included. The text file will not occupy a large amount of memory space and will have coded information related to the vehicle for which it is programmed. Small files from each vehicle will allow the receiver to store many files on its memory system; it will collect all data received to allow report generation at the end of the day. Only data with codes for flagged vehicles will provide alerts in the system. Figure 3 shows an overview of the DSRC Driver Profile System flow.
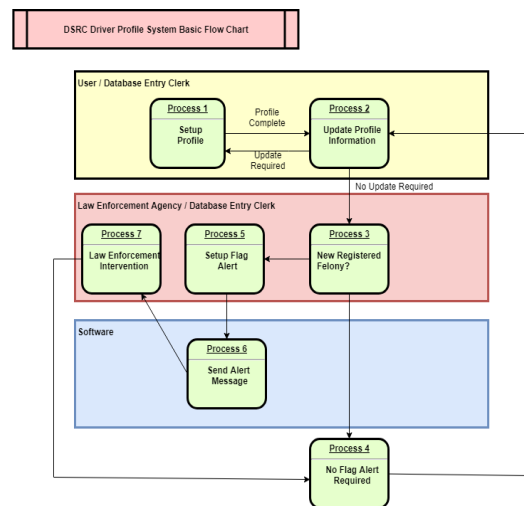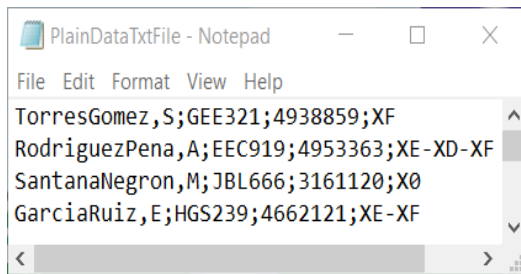

Figure 3
DSRC Driver Profile System Basic Flow Chart

An example of what kind of flags can be added to an initial release of the system can be based on the following definitions:

- Stolen Vehicle - This flag will always pop up on any nearby police vehicle. If vehicle has been reported as stolen, seal will send a flagged signal to the nearest patrol.
- Pending Insurance Payment - No alert will be created on the system, just that this car is pending an insurance payment. This means that current payment is due by the end of the month.
- Paid / No Flag -No vehicle information needs to be sent unless patrol vehicle device is setup to receive all signals.
- Unpaid Insurance - Will flag as illegal vehicle in transit.
- No Info - Seal may be broken or signal was not properly read. May require repair or new configuration.

Codes will be defined in the software for each of the flags defined. These codes will trigger an alert based on the priority level established by the laws of transit. Figure 4 displays a sample in plain text message of how the receiver data can be seen.

Figure 4
Data Received in Plain Text Data File

Alert flags will be setup by the Database User or by law enforcement officials – users of the software will only be able to update driver information; for example, secondary authorized drivers for a vehicle in the household, as well as update mailing and residential address and any payments related to the system. User can flag their vehicles by contacting a law enforcer and reporting any felony against their vehicle.

BENEFITS

The benefits of adopting the technology of the DSRC Driver Profile system include:

- Faster vehicle owner identification. While it will be necessary to review license on the driver, the information can be confirmed quicker by already having it displayed on the receiving device.
- Identify stolen vehicles faster. A flag vehicle will set off an alarm on the receiving device with a message displaying the type of flag, thus eliminating the longer wait to confirm vehicle data with database through phone call; or being deceived by a stolen license plate.
- Identify uninsured drivers. Flag will also identify drivers who have not updated or haven't paid their insurance information. Currently, insurance seals can be cloned and can be mistaken for an authentic one.
- More security for vehicle owners. Knowing they can flag a vehicle through software in the case of an emergency can help prevent grave consequences to the most common vehicle theft crimes.

CONCLUSION

The technology presented in this article is currently being developed or available. The goal is to work towards safety by means of vehicle communication with its environment, providing alerts of any risky conditions that can endanger a driver and other individuals. This would eliminate the human error factor that has currently led to many life-threatening situations. With the proposed DSRC Driver Profile system, vehicle information can be ready for law enforcement officials; easing the process of identification in many cases. For the individual who owns the vehicle, the DSRC Driver Profile system will provide better security and more flexibility when renewing insurance. While it is not the final state on the evolution of our vehicles, the DSRC Driver Profile system can be a big step forward towards the implementation of vehicle

communication and security with the benefits it can provide.

REFERENCES

[1] PIPS Technology: Detection Innovation. (n. d.). *Mobile ALPR Systems* [Online]. Available: http://www.pipstechnology.com/mobilealpr/.

[2] S. Krishna. (2017, June 24). *Self-driving cars are safer when they talk to each other* [Online]. Available: https://www.engadget.com/2017/06/24/self-driving-cars-mcity-augmented-reality/.

[3] Federal Communications Commission. (2019, April 22). *Dedicated Short Range Communications (DSRC) Service*. [Online]. Available: https://www.fcc.gov/wireless/bureau-divisions/mobility-division/dedicated-short-range-commu nications-dsrc-service.

[4] R. Elezaj. (2018, October 1). "How Do Self-Driving Cars Work?," *in IoT for All* [Online]. Available: https://www.iotforall.com/how-do-self-driving-cars-work/.

[5] Green Car Congress. (2016, October 25). *Savari and SAIC Motors partner on V2X technology for China* [Online]. Available: https://www.greencarcongress.com/2016/10/20161025-savari.html.