Volume 14 Issue 9
Originally issued as B1

Global Journal of Researches in Engineering: B
Automotive Engineering
Volume 14 Issue 1 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

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GJRE-B Classification : FOR Code: 290401

VEHICLEANTITHEFTANDPASSENGERSAFETYSYSTEM

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Vehicle Anti-Theft and Passenger Safety System

Sagnik Basu Choudhuri [α], J. Sam Jeba Kumar [σ], B. Venkatesh [ρ] & Rishabh Kumar Pandey [ω]

Abstract- In pursuit of improving the safety of automobile, many companies have invested in developing various systems. Engine Immobiliser is one such innovation. Eventually, the RFID based Engine Immobiliser is becoming prone to getting hacked which compromises the very purpose of the device. Ethical hacker Karsten Nohl of Security Research Labs was able to crack the Hitag 2 car immobiliser algorithm used by Dutch firm NXP Semiconductors in around six hours. The need of the hour is to design an infallible system which enhances the security of the vehicle. We propose a system with a Face Recognition System which replaces the RFID based system. Additionally, a Passive Defense System (PDS) is also implemented that further reduces the chances of vehicle theft. The system also has a Driving Assistant Module (DAM) to help the driver drive in reduced visibility conditions like torrential rainfall, dense fog and the like. Another addition is the alcohol detection which is useful in avoiding drunken driving.

Keywords: engine immobiliser, RFID, encryption, passive defence system, WrisTAS, Driving While Impaired, ultrasound guidance system.

I. Introduction

a) Engine Immobilisers

The present day vehicles have a Radio Frequency Identification Device (RFID) based Engine Immobiliser. An RFID immobiliser is a chip embedded in the top part of an ignition key. This chip sends out an encrypted string of radiofrequency signals, basically a particular number of impulses broadcast on various radio frequencies to create a specific code, when the driver inserts it into the ignition-key slot. Without this code, the car either won't start or won't activate the fuel pump.

Early RFID systems, used 32-bit encryption. That means they sent a code of 32 impulses. With 32 bits in the code, there are billions of possible combinations. In newer schemes, including remote starters that let you start a car with the push of a button, the codes have 40 bits, which increases the possibilities. With so many possible codes, the system seems unbeatable (Julia Layton, 2009).

A report published by the United Nations Office on Drugs and Crime (UNODC) in 2011 highlights the large number of Vehicle Theft cases reported in India.

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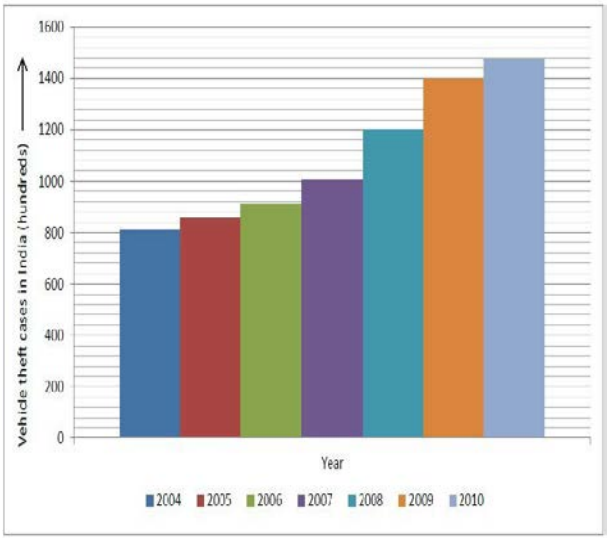

Figure 1 : Number of Vehicle Theft Cases in India

Hence, Fig 1 highlights it is a logical conclusion that the RFID Engine Immobilisers are failing in their basic task of protecting against vehicle theft.

II. Image Acquisition & Processing

Our system involves the use of Face Recognition to authenticate if the driver if allowed to run the vehicle. This can be achieved by comparing the driver's face with pre-stored templates of three people who are authorised to run the vehicle. Our system requires a camera, software where we can carry out the desired image processing techniques and finally where we can achieve the Template Matching operation based on the matching of the template and the image obtained from the camera.

The acquired image is fed to NI LabVIEW with the help of Vision Acquisition Software (VAS), which is an additional toolkit to acquire, save and display images. According to National Instruments India (n.d.) one can use NI-IMAQ to acquire images from analog, parallel digital, Camera Link cameras & NI Smart Cameras. It can also be used with NI-IMAQdx with USB3 Vision, GigE Vision, IP (Ethernet) & IEEE 1394 devices.

After selecting the source of the acquisition we have to set the acquisition type. NI Vision Acquisition Software offers a variety of solutions, Single Acquisition with processing; Continuous acquisition with inline processing; Finite acquisition with inline processing; Finite acquisition with post processing. We are using the Single acquisition with processing mode. NI Vision Acquisition Software also gives us an option to alter the

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resolution settings of the camera with the option enabling of image logging.

To operate the vehicle in the night, the template match has to be carried out in the dark. The external incident light must have excellent penetration of the skin on the face to perform template matching in the night. Medical studies have shown that near infrared light compared to other bands of light, such as visible light on human skin has strong penetration power and better absorption by haemoglobin so an infrared light supports template matching in the night (Guotian Yang, 2010). According to the research by Yuan and Tang (2011), the 850 nm near infrared light has excellent skin penetration ability, relative to other band infrared light and can be better absorbed by haemoglobin.

After the driver's image is acquired, we perform Image Pre-Processing techniques on it using the NI LabVIEW Vision Development Module (VDM). In the Vision Development Module, we convert the 64 bit image to Gray Scale which is a 8 bit image and reduce the Region Of Interest (ROI) to perform the Template Matching operation.

If the template match between the pre-stored template and the camera's image is successful, the car starts else it does not.

III. State Machine Implementation

Mathworks India (n.d.) states that a State Machine is a model which a finite set of states and behaviors and how the system transitions from one state to another when certain conditions are true.

The system first checks if all the doors of the vehicle have been latched and the driver has fastened the seat belt as well. If both the above conditions have been met, the State Machine executes the next state else it does not.

After the first state, the State Machine executes the case where the image acquisition process initiates. The driver's image is taken and is compared with the templates already stored in the system. If the template match is successful, the car starts. If the match is not successful in the first attempt the system runs the image acquisition process for an additional ten minutes. However, if the template match is not successful at all, the State Machine executes the Third Party Login.

The Third Party Login is a special case aimed to give temporary access to people who do not have their templates stored in the system yet want to run the vehicle. This system becomes very useful in specific cases like when the technician at the repair centre wants to test the car. The Third Party Login is authenticated using a four letter password which only the owner and his family know. The Third Party Login Password can be entered from a remote location as well. If the password matches the car will start else it does not. The salient feature of this system is that in the Third Party Access mode, the vehicle runs for a duration of one hour two times a day only. After the expiry of the allowed time, the vehicle automatically comes to a halt.

Further, the system also provides scope for a Passive Defence System (PDS) which comes into effect if the primary defence system, the Face Recognition and Authentication system fails to protect the car. The PDS interacts with the vehicle engine with the help of a redundant Controller Area Network Bus (CAN Bus) which gets activated only when the OTP is generated.

In case a thief steals the car, there is a separate system which generates a unique One Time Password (OTP). The OTP is mailed to the registered mail id of the owner using Simple Mail Transfer Protocol (SMTP), present in NI LabVIEW. The system also switches on a hidden camera when the OTP is generated. The hidden camera will take a set number of images of the thief without his knowledge. The image of the thief is stored in the memory which can be retrieved later and can be handed later to the concerned authorities. The image of the thief can also be sent to the nearest Police Station.

The system enables remote switching of the vehicle's engine off through the NI Data Dashboard App (Version 2.2), which helps us to remotely control the vehicle's engine (National Instruments, 2014). This app enables the owner to feed in the Third Party Access password or the One Time Password

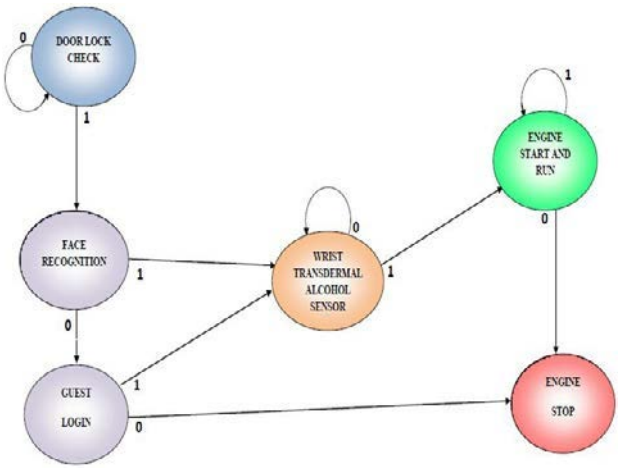

Figure 2 : Implementation of the State Machine

from a remote location. Alternatively, both the passwords can also be entered from an Internet Browser over a secured network.

IV. Need for Passive Defence System

When the RFID Engine Immobilisers came into the market everyone considered them to be a fool proof system that will keep vehicle theft in check. RFID based Engine Immobilisers are not safe anymore.

The Passive Defence System (PDS) as highlighted earlier comes into operation only if the Face Recognition and Authentication is breached.

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a) Conditions in which we may require the PDS

- The template database is stolen.
- The primary CAN Bus is corrupted.
- Attacks due to Biometric Sensor Overtness (Anthony Delehanty, 2011).

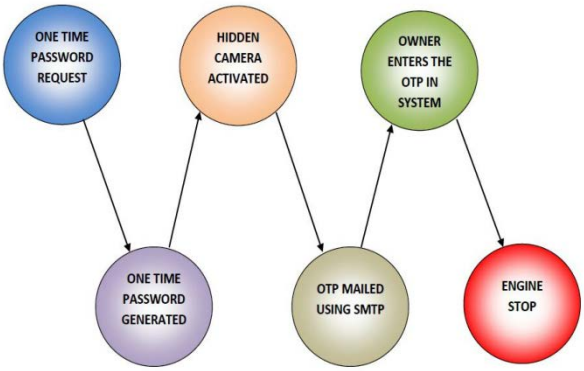

Figure 3 : The Passive Defence System (PDS)

V. Eliminating Driving while Impaired (DWI)

a) Introduction

Drinking While Impaired (DWI) is a serious offence which not only risks the driver's life but also of others on the road. Steps have to be taken to eliminate this menace. Most of the system available in the market today can detect whether the driver is drunk before starting the vehicle but they fail if the driver drinks while driving. Thus, if the driver drinks while driving, the vehicle does not stop.

In our quest to eliminate the above stated situation we advocate the use of Transdermal Alcohol Sensor (TAS) which tests for alcohol that is excreted through the skin. The two most effective TAS are:

- Secure Continuous Remote Alcohol Monitor (SCRAM)
- Wrist Transdermal Alcohol Sensor (WrisTAS)

Robertson (2006) *et al.* concluded that after more than 70 years of research and 22 peer-reviewed studies into the science underpinning this new technology, it has been established that ingested alcohol can be measured in perspiration through the process of Transdermal Alcohol Testing.

A research undertaken by Phillips & McAloon (1980) deduced that there was a statistically significant linear relationship between the concentration of ethanol in sweat and the average concentration of ethanol in blood, also called Blood Alcohol Concentration (BAC). Blood Alcohol Concentration is the amount of alcohol per fixed unit of blood.

After evaluating the needs of the system, we have selected the WrisTAS as the Alcohol sensor. The WrisTAS uses a constant hydrated platinum electrode maintained at a controlled potential and bathed in aqueous electrolyte held in a reservoir. In the WrisTAS, an electrode oxidizes the ethanol and forms acetic acid that diffuses into the reservoir. The current is converted to a digital signal that is averaged and stored at preset time intervals from 30 seconds to 10 minutes. Data can be downloaded to a computer serial port (Marques & McKnight, 2007). We have selected WrisTAS over SCRAM owing to the following reasons:

- Smaller Size of WrisTAS as compared to SCRAM.
- Paced drinking with food may not trigger an alert in SCRAM (Marques & McKnight, 2007).
- WrisTAS continuously scans for the presence of alcohol, while SCRAM does it every half an hour. SCRAM may not be able to protect against Drinking while Driving in all conditions.

b) WrisTAS Implementation

The WrisTAS can be interfaced with the car in a multitude of ways. The first method could be pasting an elongated WrisTAS patch on the steering wheel of the vehicle such that it covers it fully. This method is similar to what the Japanese Automobile giant, Nissan tried in one of its concept car.

The other method could be to connect the WrisTAS to the Controller Area Network Bus of the vehicle. When the driver wants to drive the vehicle, he has to wear the module. Marques & McKnight (2007) stated that the device has a skin resistance/conductance sensor and a temperature sensor. These sensors, when operative, can aid in determining if a person removed or blocked the device. When in service, data from the device are periodically downloaded to a computer via a serial port interface into the CAN Bus.

The temperature sensor attached to WrisTAS performs a secondary function as well. It checks if someone is trying to trick the Face Recognition and Authentication by uploading two dimensional images of the people in the stored templates into the system directly. Whenever a driver links up with the WrisTAS, the temperature sensor gives a high output. The NI LabVIEW reads the sensor values, if there is a high output the vehicle starts else it keeps rescanning the sensor output.

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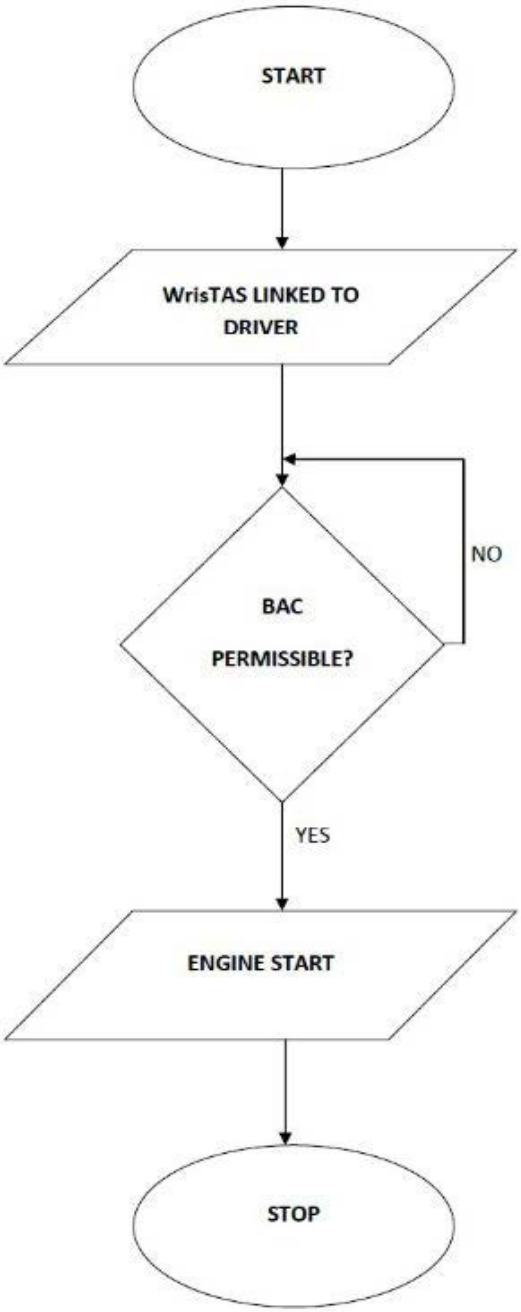

Figure 4 : Flow chart for eliminating Driving While Impaired (DWI)

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VI. The Driving Assistant Module

The Driving Assistant Module (DAM) is essentially a range finder module. The Driving Assistant Module will supplement the driver when he or she is driving by providing information about the surroundings of the vehicle. When the driver knows about the obstacles surrounding of the car, the chances of accidents are bound to reduce. The system will be particularly useful while driving in adverse weather conditions like torrential rainfall, dense fog and conditions of reduced visibility like driving in the night.

In our prototype, we have used an Ultrasound sensor module to detect obstacles in the surrounding of the car. Ultrasound sensors transmit ultrasonic waves from its sensor head and again receive the ultrasonic waves reflected from an object which is the obstacle (SensorCentral.com, n.d.).

By measuring the length of time from the transmission to reception of the sonic wave, it detects the position of the object. The process is shown in Fig. 6.

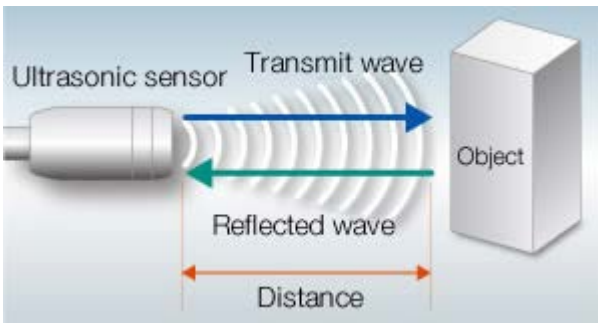

Figure 5 : Basic operation of an Ultrasound Sensor

After the data is retrieved from the sensor, it is fed to the Processing and Arduino Integrated Development Environment (IDE).

Processing is an open source programming language based on Java language and Integrated Development Environment built for the electronic arts, new media art, and visual design communities with the purpose of teaching the fundamentals of computer programming in a visual context, and to serve as the foundation for electronic sketchbooks (Wikipedia, n.d.). The user interface for the Ultrasound Sensor is made using Processing 2 IDE.

Let us consider an example which illustrates the how the distance is calculated using an ultrasound sensor.

The sensor sends an ultrasonic ping at a time t_1 and receives the bouncing ping at a time t_2.

If we know the speed of sound, the time difference $\Delta t = t_2 - t_1$, can give us an idea of the distance of the object from the Ultrasound sensor.

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If Δt = 500 μs, we know it took 250 μs for the ping to hit the object and another 250 μs for it to come back and strike the receiver.

The approximate speed of sound in dry air is given by the formula:

$$c = 331.3 * \sqrt{(1 + T/273)}$$

Where, c= Speed of sound in dry air

T= Temperature of dry air

At T= 20°C, c = 343.5 m/s

Converting the speed of sound from m/s into cm/μs:

$$c = 343.5 * 100 / 10\text{^}6$$

At T= 20°C, c = 0.03435 cm/μs

Hence, the formula to find the distance, D is

$$D = (\Delta t/2) * c$$

D = 250 * 0.03435 = 8.6 cm

Thus in this particular case the object is at a distance of 8.6 cm from the Ultrasound Sensor.

Figure 6 : Proposed display of Driver Assistant Module

VII. Conclusion

The primary focus was to replace the existing RFID based engine immobiliser with a better and foolproof system which was achieved by implementing Face Recognition as the primary defense mechanism against vehicle theft, using NI LabVIEW and its toolkits. A Third Party Access mode also been developed to help people who do not have their templates stored in the system to run the vehicle for a pre- programmed amount of time. The Passive Defense System (PDS), which includes the OTP generation and it's mailing, is also implemented using the State Machine in NI LabVIEW. A Transdermal Alcohol Sensor interface is proposed which adds to the safety of the driver and the surroundings by avoiding Driving in Impaired condition. Apart from these, an ultrasonic sensor based guidance system is also integrated to the vehicle so as to provide a guidance system to the driver during adverse cases such as heavy fog or poor visibility. All these systems work as a package and offers greater passenger safety while reducing the risk of vehicle theft.

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