Maestría en Ingeniería en Automatización de Procesos Industriales

Title

Implementation of an active safety system for the detection of drowsiness in the driver of an automotive vehicle

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1. Introduction

Life is made up of small actions that are done every day. An important every day action is driving a car. This action can be made safer with a few small changes.

In Mexico, most vehicles only incorporate passive safety systems. The ten best-selling cars do not have active safety systems [2] because such systems are only integrated into high-end vehicles, and these are not within reach of the majority of the population.

The problem addressed in this thesis work is to implement an active safety system for the alert state of the driver.

The proposed solution to this problem is to continually sense the driver's state through images and, once the driver is perceived to be in a state of drowsiness, communicate with the vehicle via the CAN bus to activate alarms inside and outside the unit.

2. Objectives

2.1. General Objective

To Implement a low-cost active safety system that can be installed in mid- and low-range vehicles, detecting the driver's possible state of sleepiness, communicating with the vehicle using the CAN Bus and activating audible and visual alarms.

2.2. Specific Objectives

- To detect when the driver enters a state of drowsiness.
- To establish communication between the detection system and the vehicle CAN Bus.
- To implement the system and sensors in the vehicle.

3. Method

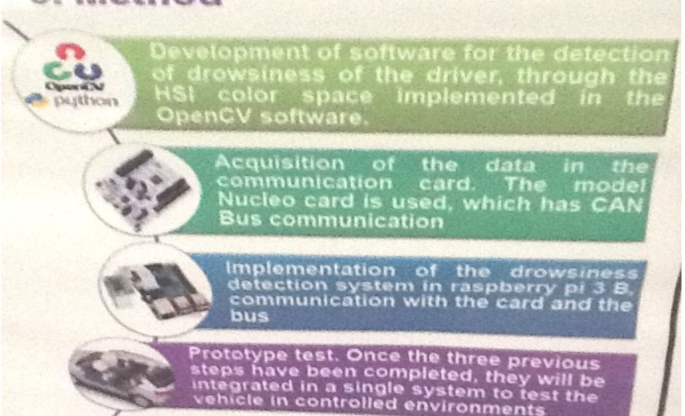

Figure1. Methodology utilized in this research

4. Results

The image processing was performed, converting the captured image of the RGB (Red, Green, Blue) color space to the HSI (Hue, Saturation, Intensity.) color space. The image was converted to find an average range of pixels with the eye open (309° to 357°), allowing us to monitor when a driver is awake.
The instrumentation of the elements to communicate the vehicle with the embedded systems was performed here.
interpretation of the data obtained from the protocol CAN Bus was performed

Detection system tests

Figure 2. The top image is of a person with their eyes open, in RGB, with good illumination. The bottom image shows the result in an HSI color spectrum, with a reddish tone seen in the area of interest in the eyes.

Figure 3. Under lower lighting conditions, the hue range decreases to 129 ° -246 °. To solve this problem, the intensity [4] is increased to establish the hue within the viable ranges.

Figure 4. In this figure a person is shown with their eyes closed. In the lower part, the image processing in the HSI spectrum is seen and demonstrates that there are no reddish pixels in the eye area.

Figure 5. In the top image a person is shown in the RGB spectrum with their eyes open and using reading glasses. The bottom picture shows the person in the HSI spectrum, illustrating that the lenses of the glasses do not affect the image conversion.

Figure 6. A person with their eyes closed and wearing reading glasses is shown in the RGB spectrum in the top image. The bottom image shows the person in the HSI spectrum, showing again that the lenses of the glasses do not affect the image conversion.

Figure 7. In the top image, the person is seen in the RGB spectrum wearing sunglasses. In the lower image, it is observed that the system can not perform the clearing of the eye, i.e. it is not known if the person's eyes are open or closed.

Obtaining the H component

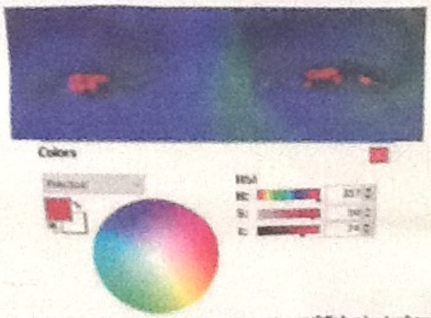

Figure 8. Obtaining the value of the hue (H) in the reddish pixel when the person has their eyes open.

Figure 9. Obtaining the value of the hue (H) in the same area when the person has their eyes closed.

Specific Case		Hue	% Of Pixels	Intensity
Good lighting	Open eyes	308° to 357°	7% to ± 16%	56 to 65
	Closed eyes		1% to ±0.5%	31 to 49 (Adjusted)
Bad lighting	Open eyes	310° to 343°	6.5% to ±15%	85 to 99
	Closed eyes		1.3% to ±0.9%	20 to 37 (Adjusted)

...ble 1. Value ranges determined in the HIS color spectrum. The percentage of pixels corresponds with open or closed eyes determined by the hue in the image.

CAN Bus Communication

Communication from the CAN bus OBDII to the vehicle, done by serial communication whith PC through Nucleo board and CAN Bus Shield demostrated in Figure 10.
Also sensing the person's heart rate helps detect when they are entering a state of drowsiness, signified by their heart rate dropping below 60 beats per minute presented in Figure 10.

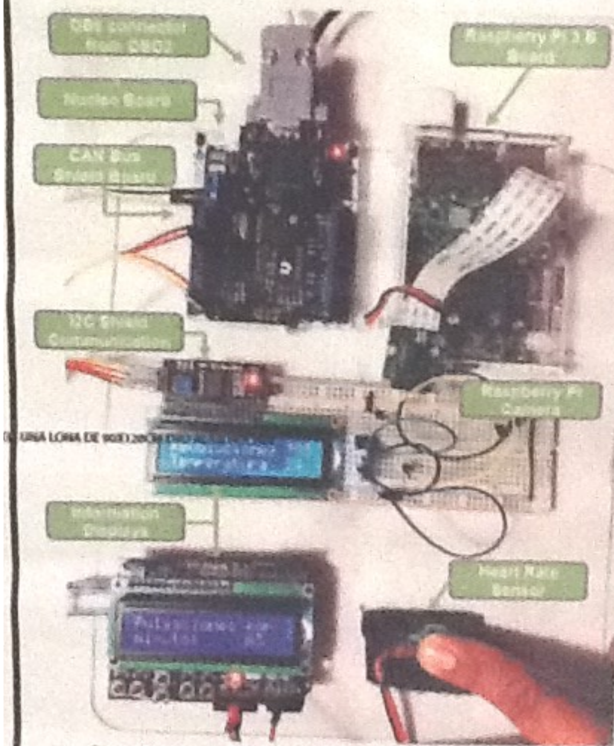

Figure 10. Instrumentation for CAN bus communication with the vehicle.

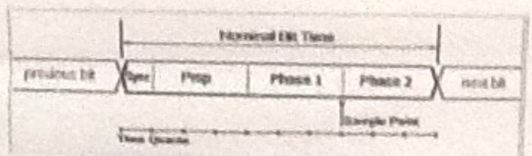

Figure 11. Quantizing a CAN bit with 10 bits of time per bit.

5. Conclusions

- Lives can be saved by integrating a system to detect when drivers are falling asleep at the wheel.
- Detection of the state of the driver's eyes can be accurately monitored.
- Comunication between the CAN Bus of the vehicle and the Nucleo board is carried out with the system demonstrated here.
- Detection of a driver's heart rate has been correlated with there alertness at the wheel.
- A driver's state of drowsiness can be determined by the system presented.
- According to the preliminary results 75% of the proyect has been complete.

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